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Railways, Electric Railways, Elevated and Cable Railways, Horse and Motor Railways, Highways, Bridges, Tunnels and Canals, Water-Works, Irrigation, Sewers, Streets, Electrical, Contract Prices, Miscellaneous, Manufacturing and Technical, Current Price List.

The Mozier block signal system, now in operation on the third division of the New York, Pennsylvania & Ohio R. R., has lately been adopted by the Cleveland, Akron & Columbus R. R., and the equipment of six of the stations has been completed. The Mozier Safety Signal Co., of Galion, O., also has an order for equipping 62 stations on the Chicago & Erie R. R., and reports prospective orders for several other lines. It is a single track block system, worked by operators in conjunction with the train dispatcher's orders. A three-position semaphore is used, and the signal levers and telegraph instruments in the cabin are so interlocked that the operator cannot use the instrument (and, therefore, cannot answer a call or acknowledge an order) unless the signal is at "danger."

A new process of tempering a 14-in. Harveyized armor-plate was tested at Bethlehem on Jan. 16. Heretofore this was done by ejecting ice-water against the red-hot plate, in a vertical position, with the result that the water was made boiling the instant it touched the upper end of the plate, and the heated water running down did not have the proper effect on the rest of the plate. In the new process the plate was laid down in a specially prepared frame; the water was made ice-cold by treating it with salt, and was then led to a large sprinkler lowered within one foot of the plate. The water was forced through the sprinkler under great pressure, while the under side of the sprinkler was kept cool by water running over it from a fixed spigot. The sprinkling continued for 1½ hours, and the plate was then taken up by a crane and immersed in the oil-baths there, to remain 30 hours. The government officers present regarded the new process as highly successful.

A good illustration of the increase of journal friction with decrease in temperature has been furnished by the gravity railways in the anthracite coal region. According to the press reports, the severe cold weather of the past week has greatly hindered the operation of these roads, some of which form important links in the transfer of coal from the mines to the steam railway lines. The friction of the journals was so much increased that cars had to be started with pinch bars on grades where ordinarily they move off as soon as the brakes are released.

The Manhattan Elevated Railway has applied to the Rapid Transit Commissioners for power to three-track all the existing lines, except the Sixth Ave. line below 53d St., and the parts in the down-town streets, and to four-track the Bowery. These additional tracks ought undoubtedly to be granted. They will not add materially to the obstruction which already exists, while they will materially add to both the quantity and speed of transit. The most important new line proposed is one on West St., along the Hudson River, and one up Seventh Ave., Broadway and the Boulevard to the upper end of the island. The company is also reported to have acquired control of the New York & Northern R. R., which extends northward from the Harlem River far up into Westchester Co. This is considered as a sign that the elevated railway contemplates considerable extension in and beyond the "annexed district" of New York, although this reported purchase has since been officially denied.

The most serious railway accident of the week was a rear collision on the Cleveland, Cincinnati, Chicago & St. Louis R. R., at Alton Junction, Ill., Jan. 21. A freight train had been sidetracked to let the Southwestern limited express pass, but the switch was left open, and the express ran into the freight, smashing several tank cars, the oil from which caught fire. The engineman was killed, but none of the passengers were seriously injured. The baggage cars were burned, and a large crowd had collected to view the wreck when an oil tank exploded, and seven persons were killed and 40 or 50 badly burned, some of them fatally.

Two accidents, due to carelessness on the part of signal operators, have occurred on the Pennsylvania R. R. On Jan. 19 the F. F. V. southbound express from New York ran into a Newark local train between Marion and Harrison, N. J. The local train had been stopped to have some repairs made to the brake apparatus, and a brakeman had gone back. The signal at the entrance of the block had been lowered, however, and in looking at the signal the engineman failed to see the brakeman's red lantern. Two persons were killed and about thirteen injured. On Jan. 21 the first section of a fast eastbound train from Harrisburg had stopped near Docklow, Pa., to allow of repairs being made to the brake apparatus, when it was run into by the second section, which had been admitted to the block by the signalman. The rear Pullman car was telescoped by the engine and the wreck caught fire. About eight persons were injured, four probably fatally. We have commented on these accidents in another column.

Another collision, or double collision, due primarily to non-observance of the absolute block system, occured on the Pennsylvania R. R., near Deans, N. J., Jan. 24. In a rear collision of two westbound freight trains several cars were telescoped and the engine of the second train was thrown across the eastbound track, right in front of an express train for New York. The engine kept the track but the baggage car and five mail and express cars were derailed and thrown down the bank. The wreck caught fire and several cars, with mail and express matter, were destroyed, and the mail clerks were rescued with difficulty. Three or four persons were injured. It is said that the block in which the collision occurred is too long for convenience, and hence the second train was admitted before the first train had passed off the block.

A bridge failure on the Lake Erie & Western R. R. near Peru, Ind., occurred Jan. 20. A fast northbound passenger train was derailed (by a broken rail, according to press reports) within 50 ft. of the southern approach to the Wabash River bridge. The truck of the forward car left the track, bumping along the ties until the middle span of the bridge was reached, when the express, smoking, and chair cars left the track, crashing against the truss, which gave way and the entire span fell into the frozen river, 30 ft. below. The engine was dragged backward into the gap. The cars caught fire from a stove, but those of the passengers who were not badly hurt succeeded in removing the others and none were burned to death. The train was entirely consumed. One man was killed and ten were injured.

We are indebted to Mr. D. S. Hill, General Superintendent of the Lake Erie & Western R. R., for the following particulars: The structure consisted of 44 ft. of pile trestle approach, then three iron through truss spans, each 133 ft. c. to c. of end pins, with four stone piers, and then 182 ft. of pile trestle approach. One span and 44 ft. of trestle approach were completely wrecked, the rest of the structure being uninjured. The material of the bridge was all iron, no steel, erected in February, 1889, by the Union Bridge Co., of Buffalo, N. Y. "It is thought that the accident was due to one of the driving wheels leaving the track from cause not yet determined, and that the car immediately next to the engine struck the west truss, probably the second post from south end, knocking it out of place, causing the entire collapse of the span. The train was going northward. It is thought that none of the wheels of the engine or tender got outside of the guard rails. Two persons were killed and 11 injured. All the injured will recover."

A derailed train is reported to have wrecked a trestle on the Iowa Central Ry., near Morning Sun, Ia. The rear car went down and two persons were killed and four injured.

A water-works stand-pipe burst at Asheville, N. C., on Jan. 22. It was of ⅝ and ½-in. steel, 45 ft. in diameter and 60 ft. high, on a stone foundation, with a capacity of about 700,000 gallons. It is said that there was about 45 ft. of water in the stand-pipe when it burst.

A small water-works tank at Wheatland, Iowa, collapsed on Jan. 16, upon being filled, before the works had been accepted by the Council.

One of the two large steel boilers of the water-works plant at Napanee, Ind., exploded Jan. 21. The brick pump-house, which also contained the electric plant, was destroyed. Two men were killed and three injured.

The spans of the roof arches for the Broad St. station trainshed of the Pennsylvania R. R., at Philadelphia, Pa., are 306 ft. 9⅝ ins., instead of 606 ft. 9⅝ ins., as stated in our last issue, owing to a typographical error.

The kind, mileage and cost of street pavements in St. Paul, Minn., is given in the last report of Mr. L. W. Rundlett, City Engineer, as follows, the figures being for Jan. 1, 1892:

	Length, miles	Av. cost per yd.
Cedar blocks on plank	20.45	$1.25
Cedar blocks on concrete	.20	1.52
Pine blocks on plank	6.27	1.37
Pine blocks on concrete	.25	2.51
Asphalt	4.00	2.63
Granite blocks	.24	2.44
Brick	.34	2.40
Total	40.75	

Of the above miles of pavement 0.28 is mileage which has been relaid. In addition there are 2.74 miles, mostly cedar blocks, of private and bridge pavement.

The design for the tunnel under the Duluth, Minn., ship canal submitted by Mr. C. C. Conklin, of Scranton, Pa., has been awarded the $1,000 prize offered by the city. It provides for a concrete tunnel with a brick masonry lining 65 ft. wide and 32 ft. high at the lowest point, and providing passages for a roadway 20 ft. wide and 14 ft. high, a railway track, 14 ft. wide and 18 ft. high, and a foot walk 8 ft. wide and 8 ft. high. The estimated cost is $796,400.

The Chignecto ship-railway company is apparently about to resume active work. At least, at a late meeting the shareholders and holders of the outstanding mortgage bonds of the Chignecto Marine Transport Railway Co. agreed to the issue of $1,750,000 first preference mortgage bonds with which to complete the work in the specified time. A new contractor of standing is said to have undertaken the work and the directors have every confidence in his ability to complete the ship-railway. So says the London "Railway News."

The carborundum works at Monongahela City, Pa., are said to be gaining a wide reputation for wheels for grinding purposes, and the present capacity of 25 lbs. per day will be enlarged to 500 lbs. per day. The material, which is said to sell at $100 per lb., is composed of coke, feldspar and other ingredients mixed in a plastic mass, molded in a hydraulic press and heated to a white heat. The wheels are used by the Westinghouse Electric & Mfg. Co., of Pittsburg, for grinding in its lamps, and by the National Tube Works, of McKeesport, for sharpening dies without removing them from their positions. The material is also used in shaping diamonds, and it is reported that the material will be applied to paper and cloth to be used like sand-paper or emery cloth.

Several Manchester Canal bills are now before Parliament, the practical object of which is the seeking of power to borrow $10,000,000, subject to the priority of all former mortgages. In the bill presented by the directors of the canal company it is stated that the company has expended and incurred liabilities to the amount of $59,788,985. Of this amount $8,550,000 has been spent in purchasing other canals now yielding a net annual profit of $300,000. The company's bill does not state that the sum asked for will finish the canal.

A tire ordinance has been passed by the City Councils of Philadelphia, applying especially to omnibuses. It regulates the license as follows: For an omnibus with its passengers which does not weigh more than 4,000 lbs., $75; if the weight be between 4,000 and 5,500 lbs., $100; between 5,500 and 7,000 lbs., $150; over 7,000 lbs., $200, and no license shall issue for an omnibus which shall, when loaded, exceed 11,000 lbs. The ordinance provides that all omnibuses running on streets paved with asphaltum shall be provided with flat tires of width as follows: For vehicles between 4,000 and 5,000 lbs., 2½ ins.; between 5,000 and 6,000 lbs., 3 ins.; between 6,000 and 7,000 lbs., 3½ ins., and for omnibuses weighing, loaded, 7,000 lbs. and upward, 4 ins. The penalty for the violation of this provision is a fine of $100 for each and every offense. The ordinance is meant to apply only to omnibuses running regularly and continuously over the streets of the city.

Bids for about 7,000 tons of nickel-steel armor-plate will soon be called for by the Navy Department for the new warships, under more stringent specifications than those under which the 6,700 and the 6,000-ton lots are being supplied, by the Bethlehem and the Carnegie iron works, respectively.

THE CITY ELECTRIC STREET RAILWAY POWER STATION OF LITTLE ROCK, ARK., AND ITS RECORD.*

By B. J. Arnold, Consulting Engineer.

(With inset.)

Electric railway construction, like all other classes of engineering, has necessarily passed through its pioneer period accompanied by many mistakes and some failures, and although this experience has been chiefly confined to the electrical features, the power station has always been one of the most difficult and variable factors in the construction and operation of a road.

This country is covered with numerous plants built in almost all conceivable shapes and arrangements—some of which are good and some bad. Some are built without any apparent design and run with seemingly no regard for the feelings of the stockholders, while others show careful planning and are a source of satisfaction to their owners.

It is not my desire or intention to-night to criticise or belittle the efforts of any engineer who has passed through the ordeal of building an electric railway power station, large or small; for if success has been his, he deserves it; and if failure has overtaken him, there is no one who realizes it more fully than himself; and the reconciliation of his own conscience, combined with the wrath of the stockholders of the road, is sufficient punishment for his offence.

Power station construction has now settled down to a substantial basis, and the requisites for success are fairly well understood by those engineers who have paid any considerable attention to this part of electric railway work, although the results obtained depend largely upon the conditions of each case and the judgment of the engineer.

In designing a power-generating station, the engineer generally has three important questions to consider: First, the means of getting fuel and water to the station. Second, the relative location of the plant to the system which it is intended to drive. Third, the comparative value of real estate and cost of foundations between the desirable site and the available site. These conditions are different in every case, and the manner in which they are met stamps the man who is entrusted with the responsibility of the work as a success or a failure in this line of engineering.

A description of a power house is not ordinarily attended with any great degree of interest, but the peculiar arrangement and location of the one which I am about to describe seem to meet the above conditions in such a manner that I trust a description of this work will be of interest.

The engineering of this plant was placed in the hands of the writer in January, 1891, and the management of the company for whom the station was built was broad enough and had sufficient confidence in humanity to give the engineer such authority and support that he took pride in designing and constructing a piece of work which has proved highly satisfactory to the company operating it. Inasmuch as this plant was built in a remarkably short space of time, perhaps a short synopsis of the process of construction will be interesting before describing the details of the different engineering features.

Draftsmen were placed on the drawings in February, 1891, and the complete working drawings and details were finished in about 60 days, although the corrected drawings were not finished until about the time the plant was started, as the water arrangements for the plant could not be definitely determined at the time the station was designed, on account of the wells over which the station is built having been partially filled with debris.

The financial market was such that arrangements for actual construction were not perfected until early in July, 1891, and the actual construction of the power station commenced July 15, although the contractor was engaged a few days prior to this in getting his chutes and false work into position for handling the brick. Although the entire station now stands upon a solid slate foundation, considerable difficulty was experienced in securing foundations for the north wall, or the one nearest the river, owing to the slate strata being inclined at an angle of nearly 45°, dipping toward the river. It was necessary, therefore, to excavate the alluvial soil upon which the railway track stands to a depth of about 20 ft. below the railway track before solid slate was reached, and about three weeks of time was consumed in this excavation before bricklaying to any advantage could be started, although masons were put at work on portions of the foundations, wherever it was practicable prior to this.

On Aug. 8 the solid footing for the entire substructure was secured, and bricklaying commenced to advantage. During the first month the construction was delayed about ten days by rain and several days owing to excessive heat, a number of men being overcome by it; but notwithstanding this, on Aug. 22 the sidewalls of the building and all of the foundations were well under way. On Sept. 12 the boilers were set in position, and the work of bricking them in was commenced. The foundation of the smokestack was completed and the iron construction commenced the same date. On Sept. 19 the work of erecting the engines commenced, and the first floor of the building (the dynamo-room floor) was being laid over the boilers and engines. A temporary arc-lighting plant was now erected, driven by a portable engine and boiler rented for the purpose, and more or less night work was done on the building from this time forward.

On Oct. 24 the boilers were completed, and one engine and the pumping system were ready for steam. The stack was practically completed to a height of 180 ft. On Nov. 4 fires were lighted under the boilers, and the temporary lighting plant, which had previously been supplied by steam from a portable boiler, was driven from the main boilers of the plant from this time forward.

Owing to the delay of the contractor for the pipe work, it was deemed best to erect temporary pipe, as it was important that the road should start as early as possible. Nov. 21 this work was completed, and on Nov. 22 the belts were put on, and the entire plant started for the first time, and run continuously for 3½ hours during the trial trip of the road, without an accident or delay of any kind whatever.

On the following day, Nov. 23, the road was formally and permanently opened for traffic, and has operated continuously up to date without a delay of any kind in any way attributable to defective designing. During this period of 131 days, which elapsed from the beginning of the construction to the opening of the road, 32 days were lost on account of Sundays and rainy weather, leaving but 99 actual working days. During this time there were 1,000 cu. yds. of solid slate excavated, over 1,000,000 bricks laid, 333 M. ft. of lumber erected in the building and 1,000 HP. of engines, boilers and condensing machinery put in place. After the road had started, the remaining walls of the building, the front of the car barn and the offices were completed as rapidly as possible, although the offices and finished portions of the front of the building were not completed until the early part of 1892. The entire plant, however, was under roof by Jan. 1, 1892.

Having thus described the manner in which the plant was constructed, let us see what the reasons were for selecting this site and designing this kind of building.

Power House Site.—When this work was placed in the writer's hands, he was shown three different sites in the city of Little Rock which were available, one of which was the property upon which the waterworks had stood for a number of years, but had been abandoned, owing to the inability of the water company to filter the water sufficiently well for city use. Upon this property were two wells excavated from solid slate. About $15,000 had been spent by the water company in sinking the wells and attempting to filter the water. They were almost filled with sand, so that it was difficult to tell how deep they were or what might be expected at the bottom, as no records of their sinking were kept by the water company.

It was decided, however, that if this property could be obtained at a reasonable figure, it was by all means the best possible location for the power house, as it was near the heaviest grade on the line, accessible for water and fuel, and almost centrally located with reference to the railway system.

The property upon which these wells were located consisted of a lot 100 ft. wide by 350 ft. deep, extending south to North St., upon which it was decided the principal line of the road would run. This would bring most of the cars by the power station if this site were selected. Again, there was a solid slate substructure which would give a good foundation, and the profile of the land was such that the present building could be constructed. (See Fig. 1, longitudinal section.)

The idea which then presented itself was to construct a building that would bring the entire plant, including the car barn, repair shops, boiler room, engine room and condenser pit, under one roof and on one set of foundations, thereby making it very much cheaper to construct and operate than it would have been if two pieces of real estate had been purchased and two distinct buildings constructed.

Inasmuch as the water company had abandoned the property, it was sold by them to the railway company for about one-third its real value, which was a very considerable help toward the realization of the original idea. The writer first proposed that the power house portion of this building and the front of the car barn be constructed and the balance added as the requirements necessitated it, but it was afterward thought best by the railway company to build the entire building as designed.

The main line of the St. Louis, Iron Mountain & Southern R. R. runs along the river bank in the rear of the building, enabling a side track to be built cheaply and fuel to be delivered directly into the coal house with but one handling. Again, being located upon the river, and midway between Little Rock and Big Rock, overlooking the river for miles in either direction, and the Ozark Mountains in the south and west, it gives an observer situated on top of the roof the most beautiful view that can be obtained in the city, which resulted in providing for a summer theater to be placed upon the roof. To those not familiar with the location the idea of a theater on the top of a power station may seem absurd; but when it is remembered that the roof of this building has an area of over six-tenths of an acre, and is located about 100 ft. above the river, entirely removed from the noise of the machinery, and that from it can be seen one of the most beautiful views in the Ozark Mountains, the idea may not seem so peculiar.

The summer theater and garden has not yet been placed upon the roof, although arrangements are being made for its completion, and as the power station is located on the main line of the street railway, the theater cannot fail to become a source of revenue to the road that will make it quite an important factor to the company.

It should be stated that this plant stands in one of the desirable resident districts of the city; and as the smokestack has never yet been known to show black smoke, it has not yet proved a nuisance to the residents near it.

Arrangement of the Plant.—Let us now examine the arrangement of the plant. Beginning on the main line of the railway running along the river bank, we first come to a large well 30 ft. in diameter and 60 ft. deep, into which the water from the river is let for filtering. It should be noticed that the fluctuation of the water in this river is 33 ft. from high to low water, and that at certain seasons of the year the water contains a large percentage of solid matter, consisting mostly of vegetable substances; consequently, the means of handling it must be somewhat complicated. Before starting upon the plans of this plant the designer secured the government records of the river, extending back to 1844, thus ascertaining the extreme high and low water marks. A 14-in. pipe, which the water company had used, was found in place running from the river into the outside well. This pipe is laid 2 ft. below low water line, so that the water supply in the well is always insured. Below this pipe is a low-water filter, composed of a wooden framework supporting layers of charcoal, coke and pressed hay, through which the water filters by gravity into the lower portion of the well, the filters being used only when the water is exceptionally bad. From the bottom of this well, where the filtered water remains, lead the suction pipes to the condenser pumps and other pumping machinery used in the plant. These pumps are placed on brick foundations in the condenser pit, located in the boiler room. This pit is 20 ft in diameter and 30 ft. deep, and in it will be placed 3,000 HP. of condensers and pumping machinery, arranged for either jet or surface condensing from the same system of pumps, the details of which will be referred to later; 1,000 HP. is now in.

Coal House.—On a level with the main track of the railroad formerly mentioned is the side track. This track is carried across the outside well on trusses. Next to the side track comes the coal house, which is 20 ft. wide and extends the entire length of the building, and is capable of storing 300 tons of coal. That portion of the coal house which extends over the outside well is carried on iron I beams and concrete construction.

Boiler Room (See Fig 2).—The boiler room is a room 44 × 89 and 25 ft. high. In it will be placed, when the plant is completed, eight 250 HP. water-tube boilers, three of which are at present installed. Over the top of these boilers is a sheet iron breeching extending to the space between the center row of columns, where it joins the main trunk breeching leading to the smokestack located outside the main building.

The permanent stack will be built of brick and will be 84 ins. in diameter by 180 ft. high.

Engine Room.—Just south of the boiler room is the engine room, with its floor located 6 ft. higher than that of the boiler room, which permits the exhaust piping system to be located under the floor. The room is 49 × 89 ft., and will contain, when completed, 3,000 HP. of engines; three of these, aggregating 1,000 HP., are at present installed.

Dynamo Room (Fig. 6).—Passing upward from the engine room on stairs located on either side of it, we enter the dynamo room, 133 ft. × 88 ft., 6 ins. In this room will be located two distinct line shafts resting upon the tops of the partition walls of the building. From the north line shaft, which is at present installed, there will be belted eight 110 HP. railway generators, five of which are now in use. There will also be an additional 110 HP. railway generator belted directly to a high-speed engine located below the boiler room, for the operation of the "Owl Trains," after the main part of the plant is shut down. The other line-shaft is located on the top of the wall at the south end of the engine room, and from it will be driven the lighting machinery. The two shafts will be cross-connected at

* A paper read before the Engineers' Club of St. Louis, at its meeting on Dec. 7.

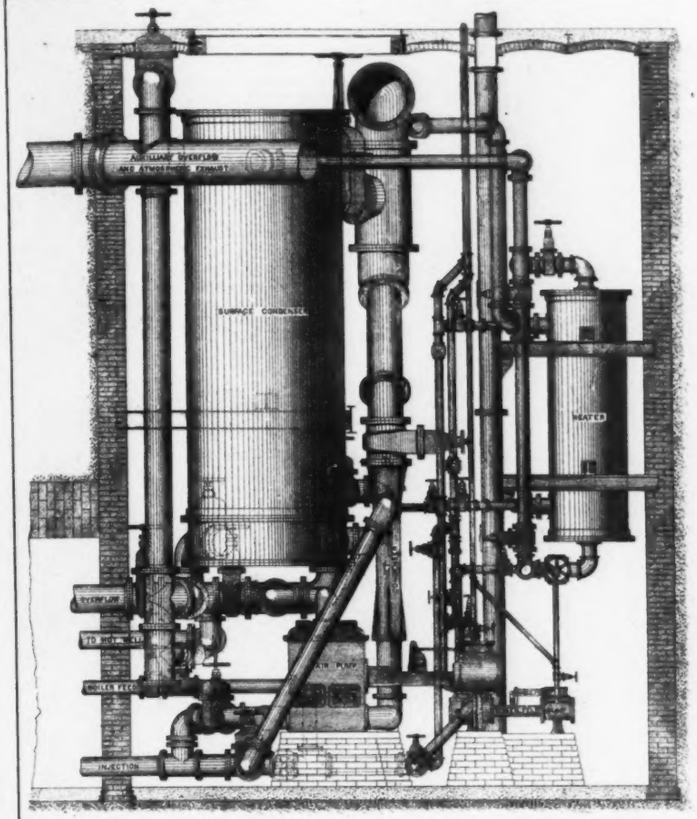


FIG. 3. LONGITUDINAL SECTION OF CONDENSER PIT.

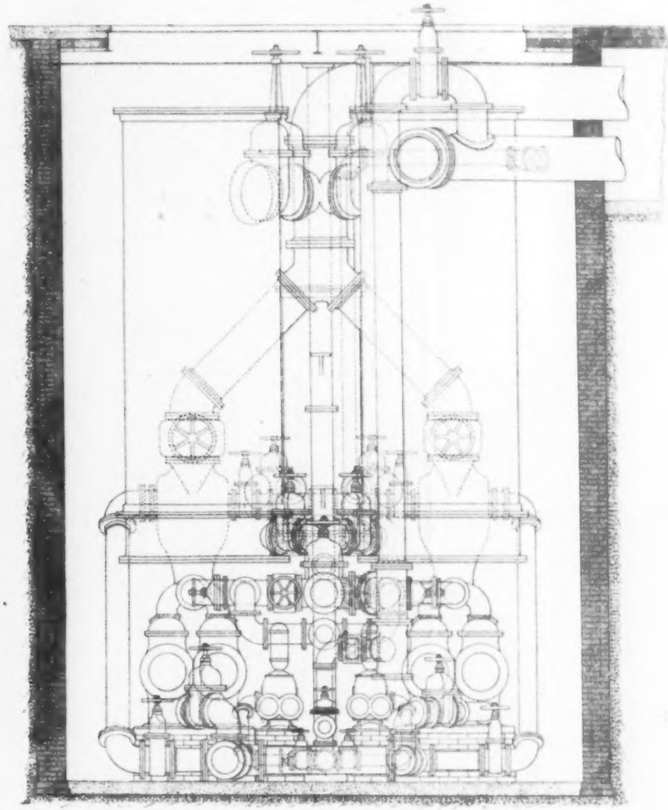


FIG. 4. TRANSVERSE SECTION OF CONDENSER PIT.

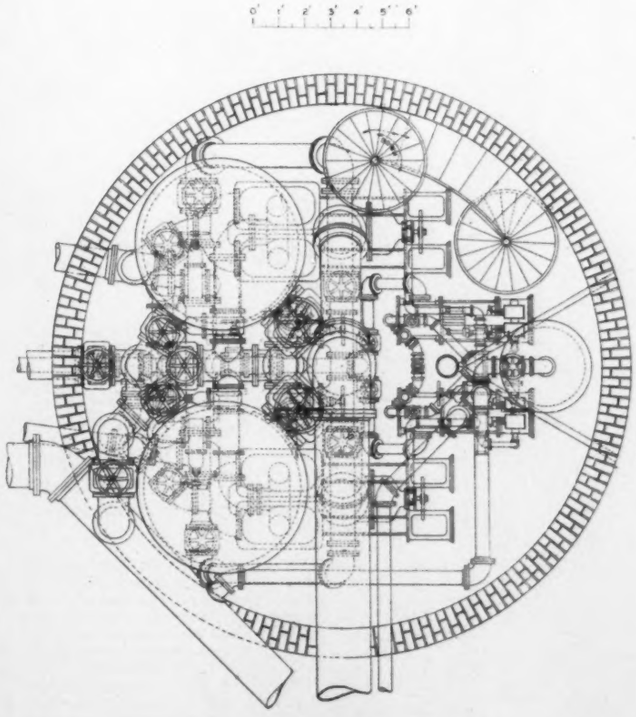
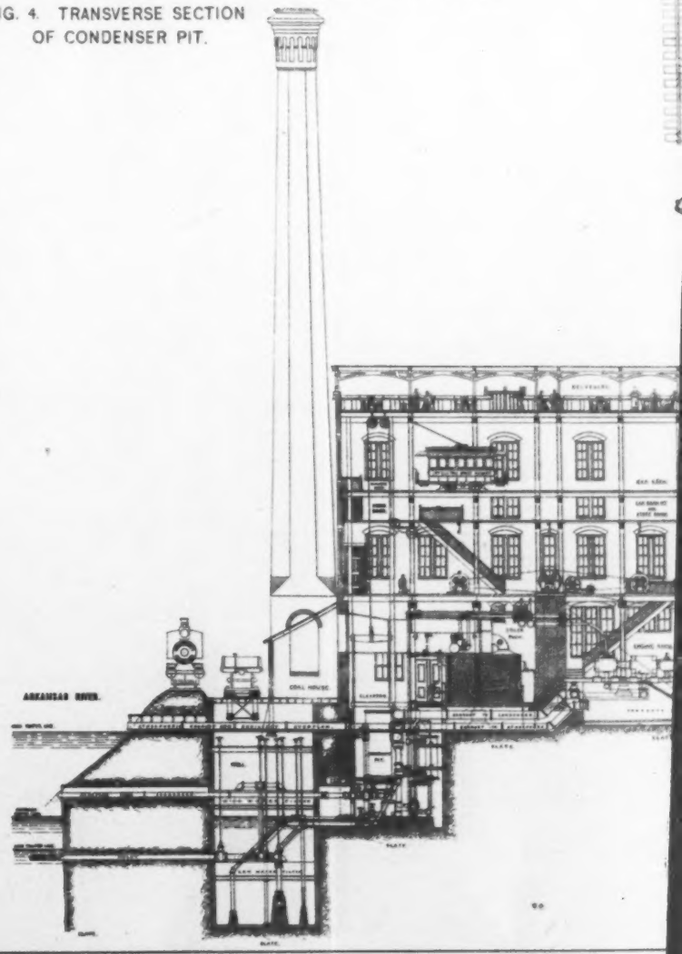


FIG. 5. PLAN OF CONDENSER PIT.



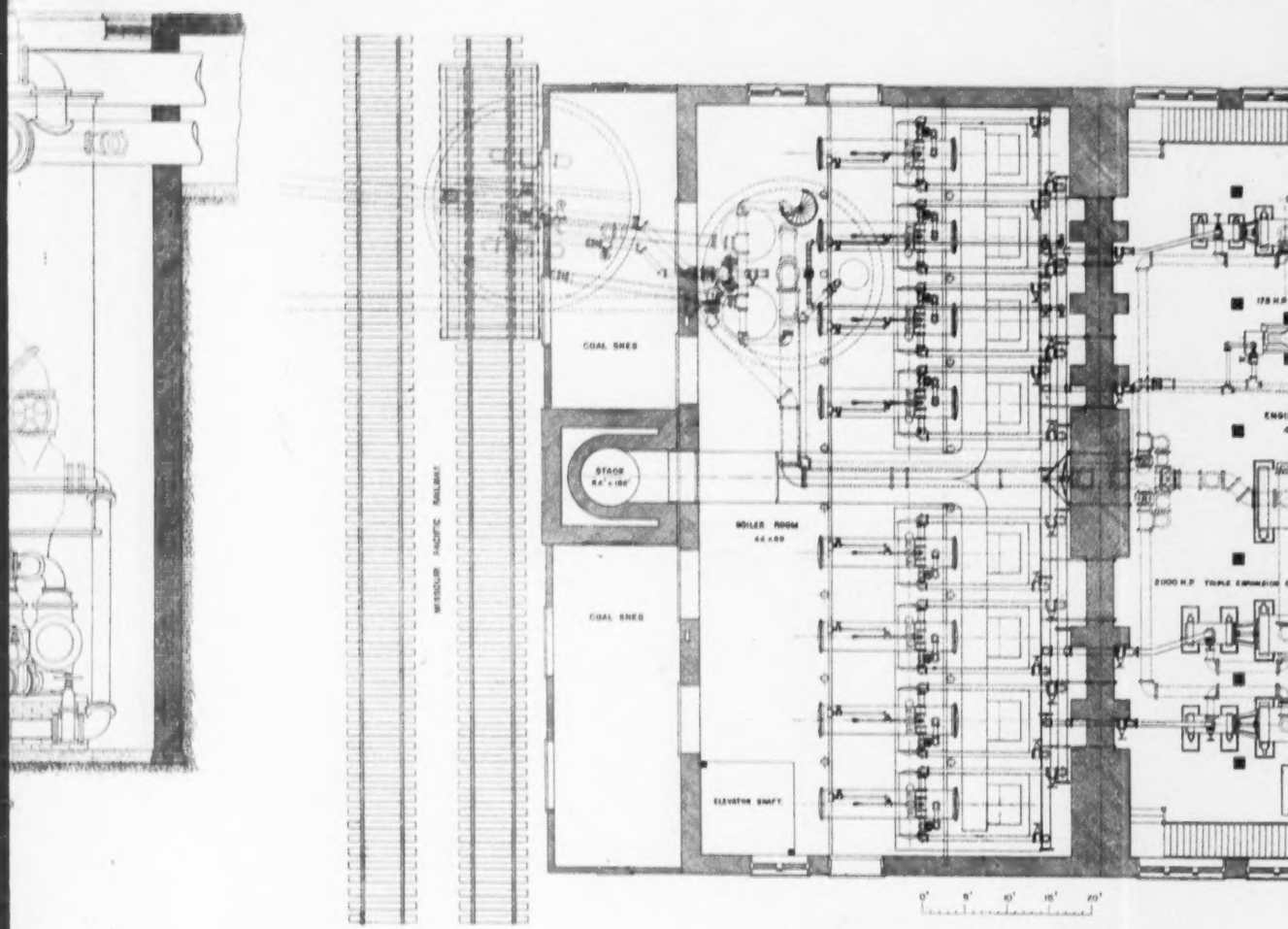


FIG. 2. PLAN OF ENGINE AND BOILER ROOM.

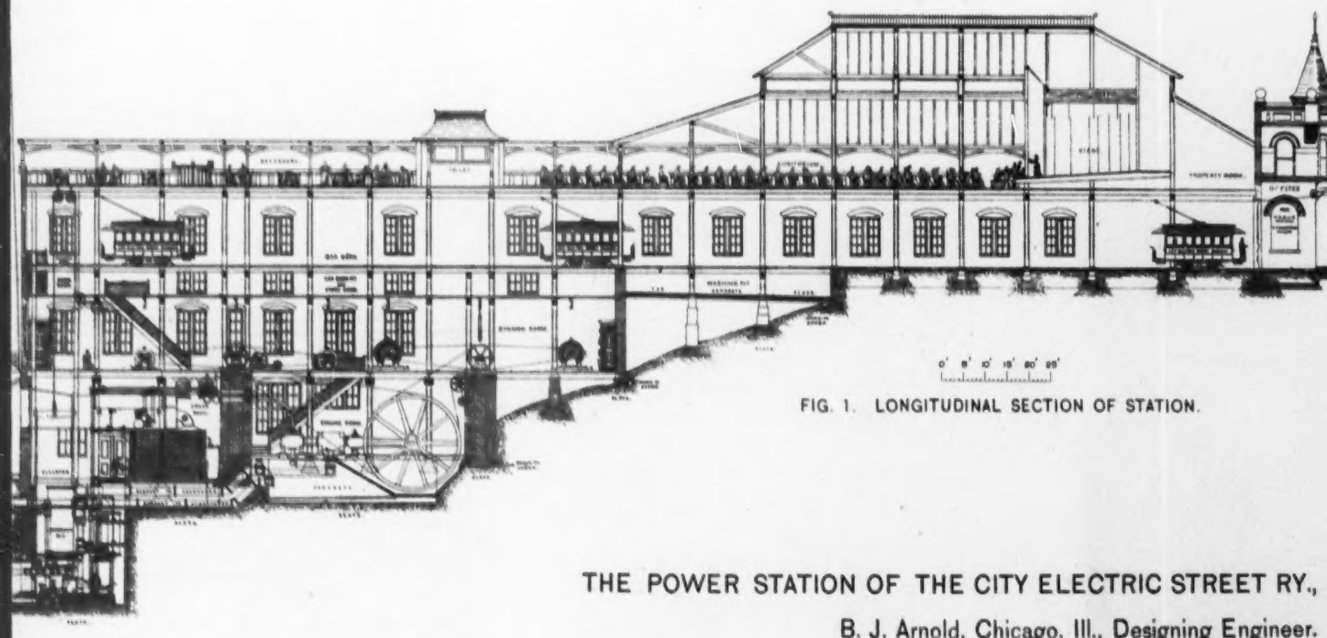
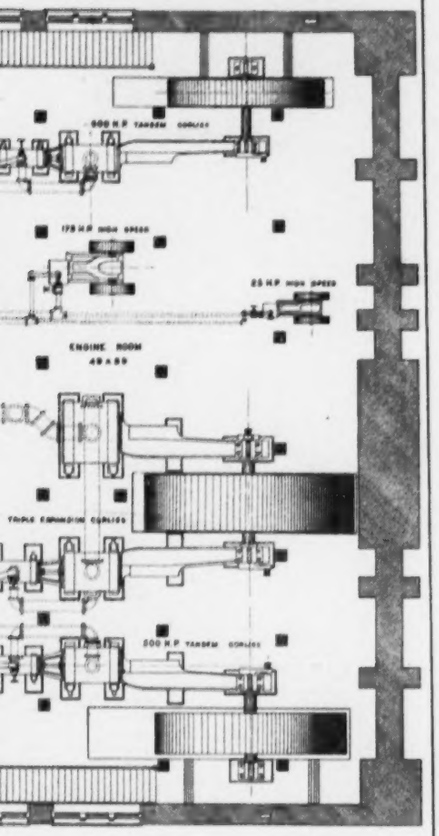
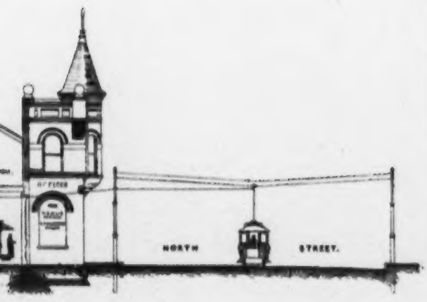


FIG. 1. LONGITUDINAL SECTION OF STATION.

THE POWER STATION OF THE CITY ELECTRIC STREET RY.,

B. J. Arnold, Chicago, Ill., Designing Engineer.





ET RY., LITTLE ROCK, ARK.

Engineer.

CHAS. HART & SONS, LITH, 26 VESEY ST., N. Y.

their centers with a 54-in. belt, enabling any generator in the house to be driven from any engine, in case of accident to any one of the engines. The railway switchboard is located in the north end of the building, and the lighting switchboard in the south end, so that the leads from the dynamo to switchboard may be as short as possible, also keeping the railway and lighting plants distinctly separate. Over each row of generators and the line of shafting an overhead single track railway with the necessary differential pulleys, etc., is designed to run for lifting out an armature or box caps. This railway runs to the elevator shaft, so that the heavy part may be delivered directly into the elevator and transferred to the machine shop above with little labor.

Pit Room.—On each side of the dynamo room are stairways extending up to the pit room above. This room was placed in the plant to provide easy access to the motors and cars for making repairs at all times, without necessitating the changing of location of the cars. In the rear of the room on the river end is a machine shop 15 ft. wide and 88 ft. long, a portion of

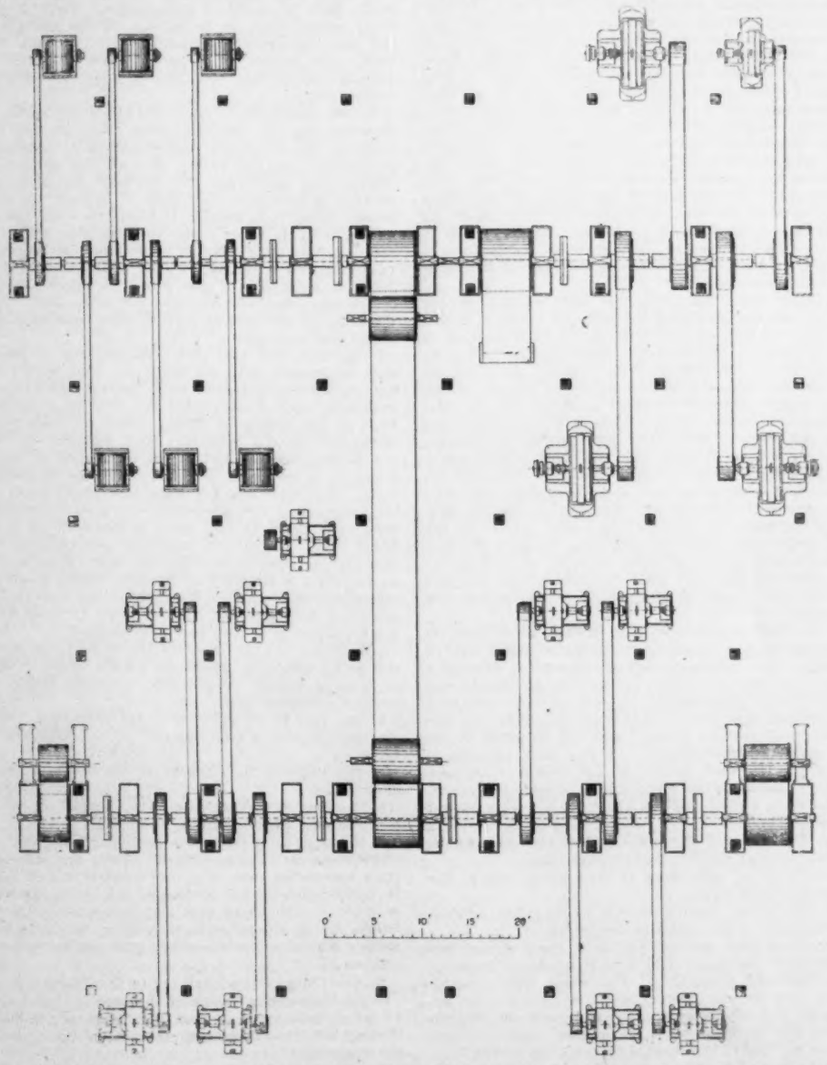


FIG. 6. PLAN SHOWING ARRANGEMENT OF LINE SHAFTING AND DYNAMOS AT POWER STATION; LITTLE ROCK, ARK.

which is partitioned off for a supply room. The heavy portions of the car machinery can be dropped down into this pit room, placed on hand trucks and drawn to the machine shop for repairs with very little physical exertion on the part of the mechanics. It also provides an easy means for cleaning the cars.

Washing Pit.—Extending 50 ft. south of this pit room is the washing pit, which has a tar concrete floor, sloping to the south, so that the drainage will run into the sewer connected at that end, and preventing the water from flowing over the dynamo room. The washing pit extends the entire width of the building under all of the tracks, so the cars from any track can be run over the pit, washed, drained and run back to place without any transferring.

Car Barn.—On each side of the pit room extend stairs rising into the car barn. This room is 38 ft. 6 ins. wide by 297 ft. long, and contains eight tracks 4 ft. 8½ ins. gage, and is capable of storing 96 motor cars. In the rear, on the river side, are located the small benches and stands for taking care of the headlights and other small repairs of the cars, giving a pleasant airy room for the car barn employees. The floor of this room has a slight fall from the rear of the building to the front, so that in case of fire the cars can be gotten out of the house rapidly. These eight tracks swing into the main line of the road with curves, thus doing away with the transfer table, which by some is considered objectionable, as in case of fire it would hinder greatly in getting the cars out.

Summer Theater.—On top of the car barn roof is to be located the summer theater and pleasure garden, before mentioned, capable of seating an audience of 1,000 people in the auditorium proper, and about 400 around the tables and places of amusement in the Belvidere. The entrance to the theater is from the front of the building up one flight of stairs, having a total rise of but 16 ft. Suitable fire escapes are designed to be placed on each side of the building when the theater is completed. It will be noticed that the audience is but one short story above the ground, so that the question of safety is well provided for. In the rear of the stage are provided dressing rooms for actors, while the offices of the railroad company are located immediately over the front of the power house and one story above the ground, and the conductors' and motor men's rooms are on the ground floor, under the offices.

Foundations.—As before stated, this station stands upon a formation of solid black slate, which is as hard as ordinary limestone. Inasmuch as the slate was fractured in different places, it was not thought best to trust it to hold the foundation bolts for the engines; consequently holes were excavated in this slate, and the foundations of the engines were built of concrete, composed of one part of Louisville cement to two parts of sand and five parts of broken granite, and capped with several courses of brick upon which the stone foundation caps for the engines are set. The foundations have proved so satisfactory that no vibration whatever can be detected in them when the engines are doing the heaviest work. The first story of the building from the foundation up to the level of the dynamo room floor is laid in Louisville cement and sand, while from the dynamo room floor to the top of the building the walls are laid in lime-mortar, composed of one part of lime to two parts of sand.

Drainage.—A drain pipe extends from behind each cross wall to the sewer to take care of the surface water that would necessarily accumulate behind these walls were no outlet given it. At all other places in the plant, where water can accumulate, suitable drain pipes are provided.

Elevator.—An elevator, large enough to take a common motor truck is to be located in the northwest corner of the building, and runs from the boiler room to the car barn floor. By this means a cinder car can be lowered to the boiler room, loaded and returned to the car barn tracks and out onto the line, where the cinders are distributed for surfacing the tracks. It also allows car trucks, supplies and heavy freight to be unloaded directly from the railway onto the elevator and raised to the floor on which it is to be used.

Electrical Equipment.—The present electrical equipment consists of 23 double 15-HP. motor cars and five 110-HP. multipolar railway generators, with the necessary switch board and overhead construction appliances, with provisions made for adding four more railway generators and other cars without any additional expense, except for the purchasing of the machinery. The plant is also designed for the addition of an electric lighting plant having a capacity of 10,000 16-c. p. incandescent lamps, and 1,000 2,000-c. p. arcs, a portion of which are now being installed.

Engines.—The present equipment of engines consists of two Corliss tandem compound condensing engines having cylinders 20×36×48 and 16×30×48, respectively. Also, one 8×10 Ideal high speed engine for driving 18 arc lights now in operation in the building. The engine room is designed for an additional 2,000-HP. triple expansion Corliss engine, which will drive the lighting plant, when installed, and one 175-HP. high speed engine for driving the railway generator to operate the "Owl Trains," or those trains that run at night after the main plant is shut down.

Boilers.—There are now three 250-HP. water-tube boilers installed, and provision is made in the boiler room for the addition of five similar boilers when the plant is extended, the connections for the steam piping being in and ready for same. These boilers have a grate area of 44 sq. ft. each. They were at first set with the manufacturer's standard setting, based on the assumption that each square foot of grate surface would burn 30 lbs. of coal per hour; but with a stack 180 ft. high, corresponding to a draft equivalent to 1¼ ins. of water, this grate area proved excessive and the area was reduced to 33 sq. ft. to each boiler, by covering the rear ends of the grate with fire brick, and a material reduction of the coal burned was the result.

Stack.—The permanent brick stack is not yet built, it having been thought best to save this expense at present and erect an iron stack suitable for one-half the plant. The iron stack thus built is 5 ft. 6 ins. in diameter, and 180 ft. high, anchored at the bottom to a brick foundation 10 ft. square at its base, 8 ft. deep and weighing 50 tons. The stack is ¼-in. thick at the base, 5-32-in. thick for two-thirds its height, and ⅛-in. thick from there to the top. It is anchored with eight ⅝-in. galvanized steel wire rope guys, running to pieces of railroad rail securely built into the masonry and covered with earth.

It will be noticed that this is a thin stack, but as it was only designed to stand five years, when it is expected the brick stack will be built, it was thought best to keep the expense down. This stack has stood a test of some of the most severe wind storms that Little Rock has known without being damaged, and has shown no signs of weakness. It was built up in sections and riveted cold.

When the stack question was being considered the writer believed that a high stack would produce combustion sufficient to prevent the issuing of volumes of black smoke, when slack coal was being burned, and, as before stated, this stack has never yet been known to show anything out of its top that could be called black. The expectation of the writer has been realized and to this fact he attributes a portion of the economy of the plant, although it should be stated that the coal is a fair quality of semi-anthracite slack.

Condensers.—There is at present one 1,000-HP. Smith-Vaile duplex jet condenser installed, with two Gordon steam pumps for boiler feeders, each one of which is capable of supplying the entire plant, assuming a consumption of 20 lbs. of feed water per HP. per hour. Provision is made for an additional 200-HP. air pump and the necessary condensing ap-

paratus. The size of the air pump and the condensing apparatus is based upon the following formula given by Seaton, in his "Marine Engineering":

$$V = 4\left(\frac{Q \pm q}{n}\right)$$

where V = the volume of the double acting pump. Q = the volume of cooling water; q = the volume of condensing water in cubic feet; and n = the number of strokes per minute.

(To be continued.)

NOTES FROM RECENT WATER-WORKS REPORTS.

An inspection of the aqueduct connected with the water-works of Washington, D. C., an account of which was given in the last annual report of Geo. H. Eliot, Lieutenant-Colonel, Corps of Engineers, U. S. A., who is in charge of the structure, showed large deposits of mud and many cracks.

Colonel Eliot states that he can find no record of a previous inspection since the aqueduct was first put in use, about 30 years ago. Deposits of mud from 12 to 54 ins. deep were found in the aqueduct and by-passes connected with it. The greatest section of the aqueduct is 9 ft. in diameter, and its total length is about 11 miles. It is estimated that a total of 15,423 cu. ft. of deposit was found in the aqueduct, which would be about 10% of its total contents when full. Some of this deposit was removed during the year by loosening it with shovels and hoes and running off the muddy water at waste weirs. An appropriation is asked to permit of the cleaning of the entire aqueduct in one year.

The inspection showed that there were many cracks in the masonry of the aqueduct, most of them at its top and over culverts. A few cracks were evidently caused by roots of trees. It is thought that most of the cracks were caused by settlement of the embankment soon after construction.

Results of the investigations made during 1891 and 1892 regarding a new water supply for Albany, N. Y., are set forth in the report of the Special Water Commission on the Normanskill supply, appended to the last annual report of the Albany Water-Works, and also in a separate pamphlet submitted in December, 1892, in which the Water Commissioners recommended that a new supply be obtained from Kinderhook Creek. The report of the Special Water Commission contains separate reports by their Chief Engineer, Mr. I. M. de Varona; by Messrs. Rudolph Hering and John Bogart, members of the Am. Soc. C. E., as consulting engineers; J. Herbert Shedd, M. Am. Soc. C. E., and W. G. Tucker, Chemist; this report also contains a proposal from R. D. Wood & Co., offering to contract and introduce a supply from the Normanskill. A second report of this commission contains reports on the biological examination of the Normanskill by Messrs. Theobald Smith and J. H. Stoller, and on chemical analyses by Mr. W. G. Tucker.

The report of the Water Commissioners, recommending a supply from Kinderhook Creek, is accompanied by reports from Messrs. Clemens Herschel and J. J. R. Croes, members of the Am. Soc. C. E., as consulting engineers; from Mr. Geo. Yost, Engineer in Charge; chemical analyses are also presented as made by Messrs. Dr. Wm. Hailes, Jr.; W. G. Tucker, M. D., and F. E. Engelhardt, Ph. D.

The Kinderhook Creek supply is still under consideration. The estimated cost of a supply from this source is $1,600,000, including a masonry dam, 45 ft. high, forming a 1,100,000,000-gallon reservoir; a 36-in. iron or steel pipe 22.1 miles long, with a hydraulic grade of 17 ft. per mile, or about 1 in 311; a 200,000,000-gallon distributing reservoir; a 36-in. steel pipe from the latter reservoir, passing beneath the Hudson River, to connect with present force main; and in addition a compensating reservoir to supply present water-right owners.

The report of the Brooklyn Department of City Works for 1891, just published, contains a number of reproductions of photographic views, showing different parts of the extension of the water supply conduit and accessories. This extension was described and illustrated in our issues of March 7, May 9, June 6, July 25 and Oct. 24, 1891.

The average daily consumption of water in Brooklyn for the year 1891 was 58,054,000 gallons, against 32,731,499 in 1881, an increase of nearly 80% in 10 years. In the same period the number of taps has increased from 60,558 to 89,493, or a little less than 48%. Of the 89,493 taps in use Dec. 31, 1891, only 2,410, or about 2½%, were metered. Up to the close of the year 442.7 miles of supply and distributing mains had been laid. These figures do not include the Twenty-sixth Ward, which is supplied by a private company.

Mr. John P. Adams is Commissioner, and Mr. Robert Van Buren, M. Am. Soc. C. E., Chief Engineer of the Department of City Works. Mr. I. M. de Varona, C. E., was Engineer in Charge of the conduit extensions.

ETHICS FOR CIVIL ENGINEERS.

(Address of Mr. S. Whinery, M. Am. Soc. C. E., retiring President of the Cincinnati Engineers' Club, at the annual meeting, Dec. 15, 1892.)

In the earlier periods of every craft or profession, the feeling that exists between the individuals engaged in it is, doubtless, one of jealousy and rivalry. In time this feeling gives way to that of tolerance, and at a still later period, the necessity for united action to foster and protect common interests brings about closer relations between individuals, which in turn often, at least, results in mutual respect, personal friendships and a feeling of professional brotherhood.

This condition could not have been brought about, nor maintained, without careful regard for the rights and privileges, and even the sentiments of each other. Naturally, questions would often arise as to what were the rights and privileges of individuals, and the duties of each to the other, and these questions would be decided as they arose, by mutual agreement. There would thus in time be accumulated an accepted set of rules of conduct, governing the relations of the members to each other.

Ethics being the science of right conduct, or the body of laws governing the relations between human beings, such a code of rules as we have referred to may properly be called the ethics of the profession; and by the term "professional ethics," therefore, we mean that code of principles or rules of conduct which is openly or tacitly accepted as governing the relations of members of the profession to each other, and to the public at large. The older professions of medicine, law and divinity, each has such ethical codes, which have become well established. Whether reduced to writing or not, their provisions are well understood, and they are regarded as binding upon the members as though they were parts of the decalogue. It would be interesting to trace the history and growth of the code of ethics of each of the professions, but time will not permit, and we can only refer briefly to the condition in which they now exist.

The medical profession has, perhaps, given more attention than any other to the formulation of a code of ethics. The American Medical Association adopted a very complete and comprehensive code of rules for the government of physicans in their relations to each other and the public, which is printed under the title "Code of Medical Ethics," and can be found in the libraries and book stores. I shall have occasion to refer to this work further on, and need only say now that it embraces the whole scheme of medical practice, and deals with the subject under the following general heads:

1. The duties of physicians to their patients, and the obligations of patients to their physicians.
2. Duties of physicians to each other, and to the profession at large.
3. The duties of the profession to the public, and the obligations of the public to the profession.

Each of these general divisions is again divided into sub-heads, which are still further treated of in detail in numbered paragraphs. The whole book occupies less than 40 small pages, but it is an admirable example of sturdy, comprehensive and condensed English, evidently prepared with the greatest care. No engineer can fail to be benefited by carefully reading it.

I have not been able to find a formal printed code for the government of the conduct of lawyers, but I am told that there is a well-defined body of ethical rules with which every young lawyer must acquaint himself, and which every attorney must conform to in his practice at the peril of being disbarred. Very often the various courts—particularly, as I am informed, the English courts—have established rules for the government of attorneys practicing before them. In this country a series of lectures on the subject was delivered before the Law Class of the University of Pennsylvania, in the year 1854, by Judge George Sharswood, one of the most eminent jurists and writers upon legal subjects of the time. These lectures were soon after printed, and in this form have become, I believe, a standard of ethics for the profession in America. While the subject is not presented in the formal manner of the medical code, of which I have spoken, it is a masterly treatment of the manners and morals of the profession, and no one can read it without a profound impression of the dignity, the elevated standard of morality, the devotion to the cause of truth and justice, the high sense of courtesy, and the loyalty to the profession with which the gifted author deals with the subject.

So, also, the ministry of each religious denomination has a settled code of ethics, which, if printed at all, may usually be found among the printed rules for church government; but I have not had the time or opportunity to examine into the subject to any extent.

Engineering is, comparatively speaking, a new profession; for, while mankind ever since creation has been brought face to face with true engineering problems, which even in the remotest periods were solved in a manner which yet excites our admiration, and while, therefore, engineers, in the true meaning of the term, have existed in considerable numbers in all ages, it is a curious fact that only in quite recent times has the occupation crystallized into a well-defined profession. It is true that the mason-architects of the middle ages, who may, perhaps, be regarded as the fathers of the profession of civil engineering, formed a distinct craft, with a complete organization, which might fairly entitle them to be called a distinct profession. But that organization embraced social, political, religious and fellow-craft features, which rendered it entirely distinct from the modern profession of civil engineering.

To this comparatively short life of the profession is doubtless due the fact that there exists no well established code of ethical conduct among its members. As suggested in the earlier part of this address, it requires time to develop the necessity for and experience to determine what rules of conduct are necessary, before it is possible to formulate them into a settled code. It would seem, however, that the time has now fully come when it is desirable and possible to collect into a formal body of professional ethical rules a statement of the principles which should govern every one who practices the profession. The discussion of the subject is, therefore, believed to be timely and appropriate.

It has been well said that a correct code of ethics must be founded upon the decalogue. This applies as well to professional ethics as to general ethics. Consequently, such a code must be built up along the lines of the system of morals, which is universally recognized as the outgrowth and sequence of the ten commandments. And as the application of the principles is universal, so a complete code of professional ethics must deal not alone with the relations of the members of that profession to each other, but must comprehend as well, their relations to the public at large. This is an important point to keep in view, for no class of men has the moral right to set up for itself a standard of conduct, which, however advantageous it may be for their selfish ends, shall disregard the rights and courtesies due to those who are not members of their particular calling.

In outlining a code of ethics for civil engineers, it will be convenient to follow the scheme of the "Code of Medical Ethics," and divide the subject into a number of topical heads, such as:

1. The duty of the engineer to the profession.
2. The relation of the engineer to his professional brethren.
3. The duty of the engineer to his clients or employers.
4. The duty of the engineer to the public.
5. The duty of the engineer to himself.

It is not at all certain that the numerical order in which these divisions are stated follows the order of their importance, nor is it contended that each can be treated entirely independent of the other. On the contrary, it will be at once perceived that these relations are so blended with each other, that it is not without difficulty that this or any other division can be adhered to.

1. The Duty of the Engineer to the Profession.

In introducing this branch of the subject, I can not do better than to quote from the "Code of Medical Ethics," the introductory language used in dealing with the same topic:

Every individual, on entering the profession—as he becomes thereby entitled to all its privileges and immunities—incurs an obligation to exert his best abilities to maintain its dignity and honor, to exalt its standing, and to extend the bounds of its usefulness. He should, therefore, observe strictly such rules as are instituted for the government of its members; should avoid all contumelious and sarcastic remarks relative to the faculty, as a body; and, while, by unwearied diligence, he resorts to every honorable means of enriching the science, he should entertain a due respect for his seniors, who have, by their labors, brought it to the elevated condition in which he finds it.

The engineer should be especially careful that the high standing and exalted character of his profession shall be fully maintained and upheld at his hands.

It is not necessary to enlarge on the peculiar functions and relations of the civil engineer, which often constitute him at one and the same time counsel, witness, judge or referee, and executioner. It is unneces-

sary to say that the exercise of such functions calls for the highest degree of intelligence, fidelity, and integrity. That engineer who does not merit and gain the unqualified confidence of the world in his fidelity and probity falls short of the most important standard by which the public judges his calling, and to that extent lowers the standard of the profession and does it a grievous injury.

Every engineer, therefore, owes it as a first duty to the profession, as well as to the public, and to himself, that his reputation, both personal and professional, should be, to say the least, above suspicion.

Every engineer owes it to the profession that he should add something to its store of professional knowledge and experience, and to this end, he should be not only a close student and careful observer, both within and outside the beaten paths of the profession, but should esteem it a duty to make public in some way, for the use of his professional brothers, whatever in the way of new data or experience his professional study or work may achieve. Of course, it is given to most of us to "train in the ranks" as it were, and few can hope to become prophets or teachers, like Stevenson or Ericsson or Roebling, but it falls to the lot of most of us to discover at some time in our professional experience some new fact or method or principle which may be of use to the profession, and we should esteem it a duty to place it at their service.

There is a prevalent feeling among engineers—which in the main is most creditable—against "rushing into print," as it is called, or against appearing to court publicity. But in this, as in other things, there is a "golden mean," which we should seek out and follow.

It is not enough that the engineer shall conform his conduct to what is generally recognized as strict morality. He must carefully avoid those minor offenses against what are called the proprieties of life, and which, while not immoral, are derogatory to the dignity and exalted character the profession should hold among men. Some such offenses may be classed as unprofessional, and among them may be named the following:

It is considered unprofessional for an engineer to resort to advertisements which consist of more than his professional card, to which there may be added a statement of the specialties which he is most competent or most desirous of following. To refer in such advertisements, or business cards, to the notable works he has executed, or the important positions he has filled, savors too much of self-adulation and boasting. He may, however, with perfect propriety, add after his name degrees conferred by reputable institutions of learning, or the fact that he is a member of one or more professional or scientific societies, because these are facts which serve as evidence to the public that he is a member in good standing of his profession. Our medical friends are very strict in this matter, and do not even permit a physician to publish his professional card as an advertisement, or announce his specialty on his door plate. The physician who should advertise himself as "late family physician to the President" would be promptly dealt with for unprofessional conduct.

The engineer should not seek immodest notoriety either for himself or his work, nor should he attempt to build up his own reputation at the expense of others. It is as true of engineering as of medicine, as stated in the "Medical Code," that,

> Medicine is a liberal profession, and those admitted into its ranks should found their expectations of practice upon the extent of their qualifications, not on intrigue or artifice.

In the medical profession, it is considered unprofessional for the physician to secure or hold a patent for any surgical instrument or medicine; upon the ground that the discoveries and inventions that he may make in the course of his practice should belong to the profession at large, and should not be claimed as the individual property of the discoverer. Some very prominent civil engineers have taken the position that the same rule should apply to our profession, and have held that it is unprofessional for the engineer to secure patents upon inventions or improvements made by him. It may, perhaps, be fairly claimed that the engineer should contribute for the good of the profession such inventions or discoveries as relate to improvements in engineering instruments or appliances, whose value is confined to members of that profession, but it is far from clear why the public at large should be entitled to the free use of the engineer's inventions or improvements, which legally and morally are as much his personal property as his transit or his drawing instruments, or his professional knowledge. It would seem that the accepted legal status of inventors should apply to engineers as well as to any other class. The law clearly recognizes that an invention is the property of the inventor, but the rule is subject to some modifications, among which the most important seems to be, that if the inventor shall have made and perfected his discovery while in the employ of another person, and if the invention relates to the work upon which he is employed, the employer may use it in his own business, but he has no further proprietary right in it. The application of this rule to the inventions of engineers would require, that if the inventor be at the time in the service of a client or employer, engaged in solving a particular engineering problem, and if his invention relates to the solution of that problem, the client or employer is entitled to the use of the invention for the purpose in hand, but the inventor may protect his invention by patent, and require compensation for its use by other persons.

Under the head of unprofessional conduct may be classed an offense which by most civil engineers is considered as not simply unprofessional but as clearly immoral. I refer to a practice which is said to prevail to a limited extent in allied professions, but which I believe very few civil engineers are guilty of—that of accepting commissions on machinery or supplies purchased or recommended for the use of a client. I need hardly go into details on this point, since I think the practice is not defended even by those who are guilty of it, except on the ground that custom has made it allowable.

The same question in a different phase presents itself to the engineer when he is asked to accept valuable presents from a contractor who is engaged upon work under his direction. The safe rule of conduct is, that the professional man may accept from the dealer or contractor such small gifts or favors as are usual between persons or friends under similar conditions, considered entirely apart from the business relation. It ought to be clear that anything more than this must be prompted by selfish and unworthy motives on the part of the contractor or dealer, who, if his offers are accepted, has the right to demand full consideration therefor, and will expect the obligation to be paid with liberal usury.

An engineer should be careful not to undertake engagements which he is not competent to fulfil with honor to the profession, justice to the employer, or credit to himself, whether his lack be of natural endowments, specific knowledge, or experience. Laudable ambition and enterprise, and self-reliance, are—particularly in the young engineer—most important and creditable qualities, and should not be condemned or discouraged. It is not possible to draw the line exactly between justifiable and hopeful self-confidence, and hopeless inability, but it is safe to say that very few young men who are entitled to admission to the profession are not able to decide for themselves what they may reasonably hope to achieve, and what for them is unattainable.

It is unprofessional for an engineer to speak disparagingly of the acquirements or the opinions of his professional brothers; to indulge in rivalries or jealousies over professional matters; to express hasty opinions about professional subjects upon which he is not fully informed; to volunteer professional advice where it is not solicited, or to critize adversely in public the professional work of another.

2. The Relation of the Engineer to His Professional Brethren.

In considering this part of the subject, we are met at the outset by a serious question—who are to be considered as professional associates?

In the professions of the law and medicine, this question admits of a ready answer, for there are established standards by which to determine who are, and who are not entitled to be considered as members of the profession, and therefore entitled to professional courtesy. In medicine, for instance, when a man has been examined by the established tribunals, and has been licensed to practice medicine, he is to all intents and purposes a full-fledged member of the profession, and entitled to all the rights and courtesies belonging thereto, and neither youth and inexperience on one hand nor age and eminence (except in so far as these qualities bring with them personal regard and favor) on the other hand can add to or take from his rights and immunities.

In the law, no man is entitled to consider himself within the pale of the profession, until he has passed a satisfactory examination and has been "admitted to the bar;" but when so admitted, he may justly claim every professional courtesy and consideration. So also in the ministry, there are established standards in every church, which make a sharp line of demarcation between the unordained and the full-fledged wearer of the cloth.

In our own profession, very unfortunately, no such formal standards have been established, and the engineer is called upon to face the fact that professional courtesy is claimed by every degree of professional standing—or want of standing—from arrant quackery and well-meaning ignorance and incompetency up to the highest pinnacle of professional ability and eminence. There are not a few persons who write C. E. after their names, whom, considered from either a personal or professional standpoint, any self-respecting member of the profession would loathe to admit as professional associates. In such well-defined cases of the genus quack, no question can arise; but where in the ascending scale shall the line be drawn? In the absence of any established standard, there would seem to be only one answer possible: Each one must judge for himself personally as to the fitness or unfitness of each applicant for professional courtesy. He will have no difficulty in placing the great majority of those with whom he comes in contact, on the side of the line where they properly belong, and he will do well in all questionable cases to give them the benefit of every reasonable doubt. No man should be condemned except on credible evidence, and very often the mantle of charity may with propriety be thrown around human weaknesses and limitations, if actuated by honest motives. When, however, the engineer is brought in contact with unmistakable cases of professional charlatanry, there can be no question as to what course he should pursue. His duty both to the profession and to the public at large, as well as his self-respect, will prompt him, not merely to refuse to treat the offender as a professional brother, but to lose no opportunity to expose him, and to hold him up to the scorn he deserves.

When we consider the vast sums of money that are worse than wasted, the failure of worthy enterprises through the charlatanry of such pretenders, and particularly when we consider that such failures are saddled upon the profession by a public who have no adequate means of discriminating between the spurious and the genuine engineer, our sense of justice and duty has no choice but to "cry aloud and spare not."

In case the engineer should be called by an employer to consult with or work in connection with such quacks, only one honorable course is open to him, and that is to refuse absolutely to have anything whatever to do with the matter until the offender shall have been unconditionally and permanently relieved; and should he then take responsible charge, he ought to point out to his employer any flagrant errors of a professional character made by the offender. Only in this way may we hope to educate the public to discriminate between the quack and the competent engineer. Of course in discharging this unpleasant duty, he should be careful to discriminate between mere lack of judgment or experience, and the violation of well known principles or facts, which every engineer entitled to practice the profession should know. Thus: A bridge may be washed away or destroyed because the engineer who designed it may not have been able to obtain correct data as to maximum high water, or because through lack of judgment he placed the structure too near the high water line. In neither case is the fact positive evidence of want of professional knowledge; but if through lack of elementary knowledge how to compute the stresses in the several parts of the structure, certain of those parts are made criminally weak, or a great and wasteful surplus of material put in other parts, there is conclusive evidence of empiricism or incompetence.

It is to be feared that civil engineers are sometimes remiss in that scrupulous regard for the rights and reputations of their professional brethren, which is so carefully observed in other professions.

It is not improbable that the want of respect so frequently shown to the profession by the public, is due in no small degree to the want of respect which the members manifest for each other. It can hardly be expected that the public will respect the members of a profession who do not respect each other. It is therefore a duty to the profession, as well as to its individual members, that every honorable professional associate should receive the highest degree of respect and courtesy at the hands of every other.

Engineers—and especially those of high standing in the profession—are not infrequently called for consultation and advice upon work that has been designed, and may be in course of construction, under the direction of a fellow-engineer who still remains in responsible charge of the work. Consultation engagements of this character are highly honorable, but they involve grave responsibilities. It requires good judgment and the most scrupulous regard for the rights and courtesies due to professional associates, to avoid giving cause for offence, and the consulting engineer is often at a loss to know just how he may safely proceed.

The medical profession has apparently devoted much care to the subject of the etiquette of consultations, and has adopted a comprehensive code of rules to govern their practice in that respect. The care and minuteness with which the proper conduct of the physician in consultations is set out, shows how important the matter is regarded by our medical brethren. Among engineers there seems to be less uniformity of opinion and practice in regard to this particular phase of professional etiquette than any other.

It ought to be regarded as unprofessional for any civil engineer to accept an engagement of this character unless he is assured it is with the full knowledge and consent of the engineer who has been and remains in direct previous charge of the work. It should be entered upon only with a harmonious understanding between the two, and the consulting engineer should be careful to acquaint himself with all that has been done by the engineer in charge, and the reasons therefor. If the consulting engineer shall find that errors of fact or judgment have been committed, he should call his predecessor's attention to the fact, and allow him first an opportunity to make the proper corrections or explanations to his employers. Should they differ in opinion, and the engineer in charge de-

cline to accede to the views of the consulting engineer, good faith to his employers will require that he should state the facts and his own opinion to them fully; but in doing so, he should be careful to make his report as deferential as the facts will justify, to the engineer in charge, and be careful to treat his opinions with proper respect, and to present his dissenting views in such a way as to avoid as much as possible the injury or humiliation of his professional associate. He must, however, never forget that his allegiance to truth and justice takes precedence over mere question of courtesy.

The same principles apply with equal force to cases where one engineer has succeeded another in charge of professional work, except, of course, in so far as personal consultation may be impracticable.

It is, of course, unprofessional, as well as in the highest degree dishonorable, to seek to undermine the work or character of a professional associate, for any reason, but more particularly so if the object is to supplant him in any position he may hold.

Engineers should cultivate friendly and cordial relations with, and the good opinion of professional brethren. I cannot do better than to quote from Judge Sharswood's "Legal Ethics" upon this subject:

Nothing is more certain than that the practitioner will find, in the long run, the good opinion of his professional brethren of more importance than that of what is commonly called the public. The foundations of the reputation of every truly great lawyer will be discovered to have been laid there. Sooner or later, the real public—the business men of the community, who have important law suits, and are valuable clients—indorse the estimate of a man entertained by his associates of the bar, unless indeed there be some glaring defect of popular qualities. The community know that they are better qualified to judge of legal attainments, that they have the best opportunity of judging, and that they are slow in forming a judgment. The good opinion and confidence of the members of the same profession, like the King's name on the field of battle, is "a tower of strength;" it is the title of legitimacy.

There is good reason to believe that this is true of civil engineers as well as of lawyers.

3. The Engineer's Duty to His Clients or Employers.

The engagements of civil engineers are of two general classes. The first, and most common one, is where he is employed in some subordinate position, upon a stated salary, under the direction of another engineer to whom he reports. To the second class belong that more fortunate order, who are employed as chief engineers, reporting directly to the officers of a corporation, or those who have a general engineering practice, and charge their clients fees, dependent on the labor involved, or the importance of the service rendered.

In the first class the superior officers stand in the double relation of professional brother as well as employer, but it is only in the latter relation that we shall consider him just now.

When an engineer undertakes to do certain professional work for a client or employer, it is obviously his duty to devote himself to the interests of that client with conscientious zeal and fidelity. His personal interests or affairs cannot be allowed to stand in the way of loyal devotion to the interests of his client. The only exception to this rule is where the demands or interests of the client conflict with the engineer's sense of right and wrong. In the practice of the law, even this exception is not allowed by many able lawyers, who assert that the attorney is justified in any action, be it right or wrong, which will serve the interests of his client. So great an authority as Lord Brougham sustains this view, in these emphatic words:

An advocate in the discharge of his duty knows but one person in all the world and that person is his client. To save that client by all means and expedients, and at all hazards and costs to other persons, and among them to himself, is his first and only duty; and in performing this duty he must not regard the alarm, the torments, the destruction he may bring upon others. Separating the duty of a patriot from that of an advocate he must go on reckless of consequences; though it should be his unhappy lot to involve his country in confusion.

While few able and cool-headed attorneys would approve so radical a view, it is within the observation of most of us that in the heat and excitement of a trial most lawyers grow somewhat oblivious to what others regard as the rights or feelings of those who find themselves on the opposite side.

It is impossible to conceive of any conditions or circumstances that would justify an engineer in violating his sense of truth and justice, in the service of a client. Some examples of practice, which illustrate and apply this vital principle, may be referred to as follows:

Engineers are often engaged to report upon the value of properties, such as mines or railroads, which the owners are offering, or are about to offer for sale. They very naturally desire, and too often expect that the engineer will make a favorable and rose-colored report, whatever state of facts his examination may disclose. It is often, tacitly, at least, urged in such cases, that the favorable conditions only shall be made to appear in the report, and that unfavorable facts be either dwelt upon lightly or altogether suppressed.

Again, engineers are frequently asked and expected, when reporting upon the estimated cost of public works, to keep these estimates within stated limits, whatever may be the probable actual cost of the work, the object being to mislead the public as to the actual status of the enterprise, and thereby induce them to invest money under a misapprehension of the facts—an offense which the law characterizes as "procuring money under false pretence."

It is hardly necessary to say that no honorable engineer can for a moment doubt what course to pursue in such cases. The truth, the whole truth, and nothing but the truth is the comprehensive formula to which every legal witness must subscribe under oath, and the engineer cannot for a moment allow his official word and honor to fall below the plane of the oath-bound witness.

Engineers employed as expert witnesses in cases before the courts are often placed in delicate and sometimes difficult positions. They are generally called by one of the parties to the case, for the purpose of testifying to certain technical or physical facts, or to express opinions upon the professional work of another engineer. Of course, no honorable engineer can, under such circumstances, so shape his testimony as to seem to distort the facts, or lead to wrong inference therefrom; but the same result may be, and doubtless often is attained by unscrupulous attorneys who, by skilfully shaping the questions asked the witness, and compelling him to answer without full explanation, prevent the presentation of the whole truth. It is doubtless often the case that witnesses are thus in effect compelled, however unwillingly, to violate the solemn oath taken when entering the witness stand. In such cases the witness, whether he be an engineer or not, cannot be justly held responsible for wrong-doing. All that he can do is to make his answers conform to the exact truth, and to take advantage of any opportunity offered to present the whole truth, notwithstanding the lawyers' efforts to suppress it. Especially should he be careful to deal justly and fairly with the reputation and work of brother engineers, upon which he may be called upon to testify. The professional man who as an expert witness will willfully distort facts, or allow himself to be made an instrument for suppressing the truth in the interest of any client, or for any fee, is a contemptible mercenary. It is difficult to conceive of anything that more effectually destroys the confidence of the public in the skill and probity of the members of the profession than the spectacle of two of these members in good standing willingly testifying or allowing themselves to be made to appear to testify to alleged personal facts which contradict each other.

The question has sometimes been raised, whether after a professional engagement has expired, the engineer is under any obligation to his former client to refrain from accepting another engagement that may be in its character inimical to the interests of that former client. Mr. Mendes Cohen, the honored President Am. Soc. C. E., in his address at the Point Comfort Convention, upon the history of the B. & O. R. R., speaks thus of the conduct of Mr. Knight, the first Chief Engineer of that road:

Mr. Knight had resigned from the Baltimore & Ohio Railroad, and had been succeeded by Mr. Latrobe, in 1842, about the time of the completion of the road to Cumberland, and now brought all the knowledge and skill acquired in the company's service during his 15 years of connection with it to bear in opposition to its plans, and to the views of its chief engineer, his former assistant. The situation may well have been embarrassing to Mr. Latrobe, whose notions of professional ethics were of a different order.

The inference is unavoidable, that in the opinion of so high an authority as Mr. Cohen, the conduct of Mr. Knight was unprofessional. It is possible that the facts, as known to Mr. Cohen, justified his harsh conclusion; but as the case appears to the unprejudiced reader the condemnation does not seem merited. Doubtless Mr. Knight acquired, or at least greatly augmented, his stock of knowledge and experience of railroad location and construction while thus serving 15 years in the employ of one of the very earliest railroads. That knowledge and experience (with the limitation noted below) became a part of his professional equipment, and was undoubtedly his personal property. After his engagement with the B. & O. R. R. had ended, he was under no obligations whatever not to accept an engagement which might be inimical to the road, and he was fully justified in making use of the general knowledge and experience previously acquired in railroad work in the interest of his new clients. Nor did the fact that his successor as chief engineer of the road had been his former assistant necessarily affect in any way the situation. No principle is more firmly established in the practice of law than that an attorney may accept cases in which he may find himself opposing the interests of a former client, whose attorney may be his dearest friend or benefactor. But if, as such attorney, he should make use of confidential information obtained while in the employ of the former client, or should take advantage of the personal weaknesses of that client, learned in the confidence of their former relations, his conduct would be dishonorable and unprofessional in the extreme. So, if Mr. Knight in his fight against his former employer, made use of confidential information acquired while engaged on the road, or took advantage of, for instance, weak points in its charter or organization, which he could only have become cognizant of through his official position, his professional ethics, as well as his integrity, might well be impugned.

This suggests another question that has sometimes arisen in engineering practice. To what extent do the facts acquired and the results reached in professional work belong to the client for whom the work is done, and to what extent do they become the property of, or can they be made use of by, the engineer?

It would seem clear, without argument, that all the original notes, maps or plans, and information, as well as the final result or report are the property of the client, who pays for having the work done, unless there is a previous understanding to the contrary. There is, however, no reason why the engineer should not retain copies of such documents as a part of his stock of knowledge and engineering equipment for other work. The information thus collected and preserved may be of great assistance to him in future engagements, and it may sometime become important as a means of defending his professional character. The privilege of using information acquired while in the services of a client is subject to one condition that no honorable engineer will violate. Such records and facts cannot be used to oppose in any way the business interests of the client for whom the original work was done.

Perhaps the question of proper fees for engineering services belongs appropriately under this division of the subject. In this matter civil engineers seem to be pretty much at sea. It is, I think, a fixed custom of the physicians practicing in each locality to have an understanding as to the scale of fees to be charged patients, and this scale is rigidly adhered to, except when special circumstances make a modification necessary or proper. Our friends, the architects, have adopted and published a schedule of minimum fees for their services, to which all architects in good standing are expected to conform. There is a crying need for concerted action among civil engineers in the same direction. It may not be possible to adopt a scale of compensation for engineering work that will apply to the whole country, but those practicing in the same locality ought to agree upon a schedule of minimum fees, below which it should be considered unprofessional to go.

The spectacle of professional men openly soliciting preference in engagements, and of bidding against each other to secure work, is humiliating in the extreme, and is derogatory to the dignity of the profession, and destructive of the respect of the public. Such conduct on the part of lawyers or physicians would be met with the prompt expulsion from the profession.

It is not intended here to suggest what are proper fees for engineering services, except in a general way. It is safe to say that in no other profession are its members so inadequately paid for their services as are civil engineers. For this they are themselves to blame to a large degree. The practice of competing for engagements has had much to do with it. Fees should be based not alone on the time devoted to the engagement, but upon the magnitude of the interests involved and the importance of the results achieved. Special knowledge or ability, or long experience, or eminence in the profession, all merit and should command special compensation.

Civil engineers employed as assistants to, or occupying subordinate positions under, another civil engineer, should above all be faithful and loyal. The superior officer has the right to expect that his instructions will be carried out strictly and cheerfully; that he will be kept fully informed as to progress or results; that his assistant will criticise in the proper spirit plans or methods of work submitted to him, and bring to his attention such desirable modifications as his closer connection and familiarity with the work may enable him to suggest; and to treat as confidential all important information that may be intrusted to him.

Subordinates should particularly avoid adverse criticism to outside persons of the plans, methods of business, or the professional merits of their superiors.

4. The Duty of the Engineer to the Public.

The engineer owes to the public his earnest services as a good citizen in the highest sense that the word implies. He has no right to neglect his share of those political and social duties which fall to the lot of every patriotic citizen. It is a fact frequently remarked that the civil engineer of the better class is not often found in the ranks of the leaders of civic or social life. This is doubtless due to his work and environments rather than to a disposition to shirk his share of the responsibilities of society. His mind is occupied with the cold and angular facts of the material world, and in fields more or less remote from the beaten paths of popular thought. His duties often make him more familiar with the aspects of the forest and the mountain than with the forms of civic life or polite society, and un-

less he is careful to resist the tendency there is likely to grow up in his mind a feeling of isolation from the thoughts and affairs of his fellow men. This ought not to be so. From the nature of his knowledge and experience, he is peculiarly fitted to render the most valuable service in the walks of civic life, and the public has a clear right to object to the hiding of his light under a bushel. What a revolution in municipal government might the public expect, if city officials, in addition to administrative ability and capacity for popular leadership, possessed the knowledge and training, and the methods of work of the civil engineer. How often it is that the civil engineer when placed in positions of trust and responsibility fails to achieve success, and to make available the good services he might render the public, because he lacks qualities of administration and popular leadership, often found in the ignorant ward politician.

It is appropriate to quote here the language of the medical Code of Ethics on this subject:

As good citizens it is the duties of physicians to be ever vigilant for the welfare of the community, and to bear their part in sustaining its institutions and burdens; they should also be ever ready to give counsel to the public in relation to matters especially appertaining to their profession, as on subjects of medical police, public hygiene, and legal medicine.

Inasmuch as the failure of the public to appreciate the high character of the profession, and to discriminate between the worthy and the unworthy among those who claim membership in it, is due largely to ignorance rather than to any disposition to be illiberal or unjust, the engineer should take advantage of every appropriate opportunity to enlighten his fellow citizens upon the nature and objects of the profession, and the standards by which its worthy members may be known.

5. The Engineer's Duty to Himself.

When the civil engineer has fully discharged his obligations to the profession, to his professional associates, to his employers, and to the public at large, there still remains important obligations to himself which he should not overlook.

Every professional man owes it to himself to make the best of his abilities and opportunities. He is entitled to every fair advantage offered him, and is justified in employing every proper and honorable means to advance his professional standing and his professional work. All this is compatible with becoming modesty and proper deference to superiors and associates.

The engineer owes it to himself to defend his professional character and his professional rights against all assaults. He should not allow himself to be made a tool to serve the ends of unscrupulous men, nor should he allow them to saddle upon him blunders or misdeeds for which they alone are responsible. Cases are not so rare where the engineer in charge of work has been compelled under protest to conform to plans or methods of work which he knows to be improper and unsafe, and when the failure which he predicted has resulted, the whole responsibility of the failure is charged to the incompetence of the engineer in charge. No engineer who properly regards his honor and reputation, can allow such imputations upon his professional character to go unchallenged.

The engineer should not neglect his personal business interests. Money is a potent factor in human success or failure. Worthy poverty is honorable, but honest competency is no less so. The one may be as a millstone around the engineer's professional neck; the other cannot but aid and accelerate his professional progress. It will secure him the best books, the latest and most improved instruments, will enable him to travel and thus visit and study the best work of other engineers, and will be of service to him in maintaining the civic and social position which success should enable him to command.

From the nature of their work, civil engineers often meet with rare business opportunities, in connection with their professional work. Many of them feel a delicacy, for which there is often no adequate foundation, about taking advantage of such opportunities. It ought to be accepted as a sound principle that the engineer may engage in any honorable business enterprise in connection with his professional engagements, that does not in any way interfere with or embarrass the interests of his employer; that cannot in any way influence his professional action in reference to that engagement, and that will not occupy time that belongs to his employer. Of course any business venture that violates, or has the appearance of violating, any one of these conditions, must be scrupulously avoided.

Finally, the engineer owes it to himself that he shall not be merely an engineer. The man who devotes his life to one idea, to the neglect of all others, may make great advances in his specialty, and thus achieve renown, but it is not the surest road to success. What is popularly called the "all around man" is most likely to merit and to attain professional success in the best sense of the words. Further, the work of the engineer is of such a character, that every kind of knowledge or culture can be utilized, and may at some time be needed in his professional experience.

I have attempted to present in outline some of the leading ideas upon this subject. It is one that merits far more attention than it has received at the hands of the profession, for while among the great body of the civil engineers of this country, the correct ethics of the profession have been understood and practiced, there have been, unfortunately, notable violations of the code, many of which are doubtless due to ignorance, or to the fact that no formal standards have been set up among us. There appears no good reason why this condition should be allowed longer to continue. It is not likely that we will be able to establish in this country any formal standards for admission to the profession, and for this reason it seems the more desirable and necessary that a standard of professional conduct should be established and maintained. If what I have said in a fragmentary manner to-night shall help to arouse the attention and interest of engineers to the matter, and shall result in a full consideration and discussion of the subject, my effort will have attained its purpose.

AMERICAN LOCOMOTIVES ON NEW ZEALAND RAILWAYS.*

By Charles Rous-Marten.

A special feature of interest in the working of the New Zealand railways is the large extent to which American engines have been tried on those lines, and the favorable results obtained.

In the original fragmentary state the railways were worked with small English tank engines, but so soon as provision had to be made for through or long-distance traffic, a new departure was taken in the direction of American practice. Although the earliest large tender engines procured were of English make, they had some features of American design, the long wheelbase mogul type being adopted. These engines, which had cylinders 14×20 ins., six coupled wheels 3 ft. 6 ins. diameter, and a leading two-wheel bogie or truck, have always done excellent work, as good proportionately as that of any other class of locomotives. But when it became necessary to run express trains recourse was had to American experience in reference to lines of 3 ft. 6 ins. gage, and an order was sent to the Rogers Locomotive & Machine Works, of Paterson, N. J., U. S. A., for eight express engines wholly of American design and build. These engines had two pairs of driving wheels and two pony trucks.

I venture to think that two errors in judgment were committed in ordering these engines. In the first place, leading and trailing two-wheel trucks were substituted for a leading four-wheel truck; and the second and third pairs of wheels were coupled instead of the third and fourth, as in the ordinary eight-wheel type of American engines. Experience has not shown this plan to be so satisfactory as that in more general American use. In the second place, the engines were not given nearly sufficient power. The coupled wheels were 4 ft. diameter, cylinders 12×20 ins., less than 600 sq. ft. of heating surface, and about 15 tons adhesion weight. With that adhesion weight they might well have had much larger cylinders. With only four tons on each of the truck axles they could well have carried such additional weight as increased boiler power would have involved. The traffic possibilities of the near future seem to have been wholly underrated. These engines did excellent work so long as they were only required to pull loads of 60 to 70 tons (exclusive of engine and tender), and to maintain a running speed of 30 miles an hour, and with light loads on favorable grades they ran easily 45 to 50 miles an hour, or even more. But when loads increased, as was soon the case, and when they were required to maintain 35 miles an hour, even on the easy road, with the heavier weights, they were beaten. Two engines had to be used with 10 or 12 cars on the easier road between Christchurch and Oamaru, and with eight cars on the 1 in 50 (2%) grades south of the latter point. This proved expensive, and a new departure had to be made, which led to a somewhat remarkable contrast being afforded between some English and American methods of practice.

Designs were prepared for ten express engines of a new type. They were to be largely on the lines of those already mentioned, but were to have an additional pair of 4-ft. coupled wheels—six in all; 15-in. cylinders and proportionately increased boiler power. The order was sent to an English firm, eminent in engine making generally, but less eminent in this particular branch of locomotive building. After long delay, the first two were delivered, with the disquieting intimation that, in order to carry out the directions as to power, it had been found inevitable to make them some 10 tons heavier than the limit prescribed, so that all bridges over which they would have to pass must be materially strengthened. A long and costly negotiation ensued, which resulted in the blame for the mistake being distributed, and also the cost of altering the engines so as to bring them within the necessary limits as to weight. But meanwhile the New Zealand government, disgusted with this experience, and much in want of the engines, entered into a contract with Burnham, Parry, Williams & Co., the Baldwin Locomotive Works, Philadelphia (who had previously supplied six freight engines of the consolidation class, which had worked for several years very satisfactorily), to furnish six express engines of the same class as those ordered from England (Eng. News, Nov. 14, 1891), as well as six more consolidation engines, ten of the latter class having also been ordered from England, but not having been delivered.

The difference in the two experiences was startling. The Baldwin Works shipped the 12 engines at New York within five months of the date when the instructions were dispatched from New Zealand. The engines were received in good order, were of the guaranteed weight, needed little or no attention, and on being put to work—which they were in a very short time—realized all that was required and expected. It is not strange that, in view of this contrast, American engine building should stand high in New Zealand estimation, especially as the Baldwin engines cost $2,000 each less than the English ones. These engines, both

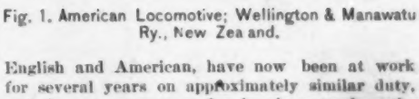


Fig. 1. American Locomotive; Wellington & Manawatu Ry., New Zealand.

English and American, have now been at work for several years on approximately similar duty, and the net outcome, so far, has been to show the American engines more economical than the English engines. It must be remembered, however, that an exact comparison is not practicable without special experiments being made under identical conditions. The figures I am about to quote are those obtained as a result of work done in the ordinary course. I take for comparison the mileage of the respective classes of engines and their average cost in pence per mile (which we have changed to cents per mile.—Ed.)—discriminating between their expense in fuel and in repairs—over a period of seven years:

Class.	Mileage per annum.	Cost in fuel, cts.	Cost in repairs, cts.	Total cost per mile, cts.
Express Engines.				
American (N)....	21,600	6.26	4.18	10.44
English (V).....	19,400	5.24	6.88	17.80
Consolidation Engines.				
American (O)....	16,600	6.20	5.62	19.30
English (P).....	13,300	6.78	6.56	20.56

This would appear to show a small but decided advantage in favor of the American engines. The figures are copied from the official returns of the Locomotive Department.

It is a weak point in the comparison that in express work the English engines have mostly been left to the Dunedin and Oamaru division, where the ruling grade is 1 in 50 (2%) and the speed 20 to 25 miles an hour, while the American engines have run on the Christchurch and Oamaru division, where the ruling grades are about 1 in 200 (0.5%), and where the speed is 35 miles an hour.

I have made many observations on the footplate at various speeds with different loads, and have always found the American engines run more easily and steadily, while they have attained speeds which it is deemed unwise to attempt with the English ones of nominally the same power. I am not aware of the English engines having in any instance exceeded 50 miles an hour. But with the American I succeeded in obtaining, on different occasions speeds of 54, 55, 57.7, 58.5 and 59 miles

* Particulars and illustrations of American and colonial built locomotives in New Zealand, and a colonial built saloon car, were given in our issue of Nov. 14, 1891, and particulars of the railways of that colony, which are of 3 ft. 6 ins. gage, will be found in our issues of Nov. 14, 1891, and Jan. 9, 1892.

an hour down slight descending grades or on the level. One also ran at 40 miles an hour on the level with a load of 150 tons. Another took a load of 81 wagons or freight cars, equal to over 600 tons, on a slight descending grade at 20 miles an hour.

But perhaps the most noteworthy records made by American engines in New Zealand have been on a railway, which, although it forms part of the government main trunk line of the colony, is in the hands of a private company, by whom it was projected, designed and constructed, and is now worked—the Wellington & Manawatu Ry. This line was originally worked with ten-wheeled English tank engines having cylinders 12 × 18 ins., and six 3-ft. driving wheels. As traffic developed, some express engines were ordered from England at the same time as those about which all the trouble occurred were imported by the government lines. These have worked well, but like those on the government railways have given much trouble and required much attention. Consequently, when additional locomotive power was required the directors, on the advice of the locomotive engineer, Mr. Arthur Fulton, M. I. C. E., and after his death, of his successor, Mr. J. E. Fulton, M. I. C. E., decided to send to America and not to England. Some engines of two classes were accordingly procured from the Baldwin works and have given entire satisfaction.

One class is of the consolidation type, but of much greater power than any other engines of that class yet seen in this country, having cylinders, 16 × 20 ins., and eight coupled wheels 3 ft. 6 ins. in diameter. Engines of this class work both the express and ordinary trains over the first section out of Wellington, the grades being from 1 in 36 (2.8%) to 1 in 40 (2.5%) for nearly five miles at starting, with subsequent stretches of 1 in 56, 1 in 57 and 1 in 66 (1.78, 1.75 and 1.5%). I tested one of these engines with a load of 150 tons at 16 miles an hour up a bank of 1 in 56 (1.78%) also at 36 miles an hour up 1 in 200 (0.5%), and at 42 miles an hour on the level with a like load.

The other class is almost identical with the latest American express engines already described as being used on the Christchurch and Dunedin expresses, and as having been so promptly supplied by the Baldwin Locomotive Works at the time of the trouble with the English firm. The chief dimensions are as follows:

Cylinders	15 × 20 ins.
Driving wheels (6) diam.	4 ft. 1½ ins.
Truck wheels (4) "	2 " 4½ "
Weight on leading truck	11.648 lbs.
" on 1st pr. of drivers	16.576 "
" on 2d " "	16.016 "
" on 3d " "	15.008 "
" on trailing truck	9.632 "
" total on drivers	47 000 "
" total of engine	68.880 "
" of tender (8-wheel)	43 680 "
" of engine and tender (loaded)	112.560 "
Heating surface	853 sq. ft.
Grate area	16 " "
Boiler pressure	140 " "

The engine is fitted with steam sanding apparatus and steam brake, also has balanced side valves and compensated axle springs. An elevation of the engines (Fig. 1) is appended, together with a profile of the line on which the engines work, Fig. 2.

Some little time ago it appeared likely to become necessary, for special reasons, to run express trains as rapidly as possible over the line, and an experiment was decided upon with a view of ascertaining what could actually be done in this way. The fastest train previously run on this line had covered the 83¼ miles between Wellington and Longburn in 2 hrs. 58 mins., running time; that is, exclusive of stoppages, two in number, at the rate of 28 miles per hour. That, however, was with a very heavy load of 150 tons, and with a change of engines at an intermediate point. In this case it was resolved to try the engine with a very light load of only two cars, weighing approximately 25 tons in all, and to run at the highest velocity practicable. This was done with a result which I believe constitutes a record for the 3 ft. 6 in. gage.

A good start was made, the engine easily maintaining a speed of 30 to 33 miles an hour up the steep bank of 1 in 36 to 1 in 40 (2.8 to 2.5%) for five miles. Just over the summit, at Johnsonville, a signal stop unfortunately had to be made, owing to a bad washout through heavy rain on the previous night. This caused a delay of over four minutes, and after the train resumed its way special care had to be exercised in ascending the steep grades, as there was danger of landslips. Speed had also to be slackened through Porirua and Paikakariki stations to cross trains. Thus Otaki, the first scheduled stopping place, was not reached until 76 minutes after the start—or in 72 minutes running time—the distance being 46.1 miles. But the time for the 40 miles from the special stop at Johnsonville was exactly one hour, of which the last 19 miles occupied only 25 minutes, or at the rate of a fraction over 45 miles per hour, the maximum rate obtained being 55 miles per hour. A stop of 4½ minutes took place for water, oiling and examination, the latter being especially careful, as it was determined to attempt something much more exceptional in the ensuing part of the run.

Four miles of 1 in 100 up grade had to be faced at the outset, which caused the first 5½ miles to occupy 9½ minutes. The next 10 miles fluctuated, keeping at about an average level, and here the speed soon rose. Down two descending grades of 1 in 300 and 1 in 100, respectively, each about three miles long, there was speedy increase to 50, 55, 58, 59 and 60 miles an hour. A mile was next done in 59 secs., giving a rate of 61 miles per hour, but directly afterward the engine had to slow down to 25 miles per hour for repairs at Kererou station. After this check the engine was put to its best along an extended stretch of level line. A speed of 60 miles was soon regained, and this average rate was then maintained continously for 15 miles, being occasionally slightly exceeded. The fastest complete mile was done in 56.2 seconds, but the quickest quarter mile was run in exactly 14 seconds, equivalent to a speed of 64.4 miles an hour. Speed had to be slackened over the Manawatu bridge, and its sharply curved approaches, two miles short of the destination, but the train finally ran into Longburn Junction station precisely 46 minutes after starting from Otaki. The distance is 37.07 miles; thus the average rate, including starting and stopping, and two bad stretches was 48.5 miles per hour. I was present on the footplate, by invitation, and the times were independently taken by Mr. J. E. Fulton, Locomotive Superintendent; Mr. J. Marchbank, Assistant Engineer, and myself. On comparison they agreed satisfactorily. The times through stations were taken to the nearest fraction of a minute, those of the miles and quarter miles by chronograph to fifths of a second. The following is the log of the train over its quickest part of the run:

Distance, miles.	Station.	Time, m.	Speed, per. h.
——	Otaki (dep)	10.40½	——
5.50	Manakau (pass)	10.50	36.6
9.15	Ohau (pass)	10.55	43.6
14.11	Levin (pass)	11.0¼	54.5
17.08	Kererou (slack), (pass)	11.5 2-3	43.2
22.42	Shannon (pass)	11.10 2-3	53.4
25.70	Makerua (pass)	11.14	60.3
29.82	Tokomaru (pass)	11.18	60.5
33.36	Linton (pass) (Slow over bridge)	11.21½	60.6
37.07	Longburn (arr)	11.26½	45.8

The engine steamed very freely, often blowing off. It may be mentioned that out of the total distance of 37.07 miles there were nearly nine miles of 1 in 100 (1%) rising grade. The line is laid throughout with steel rails weighing 53 lbs. per yard. The ties are heavy, the ballast good, and the curves easy, none of those where the high speed was run being sharper than 80 chains radius, while all the strongest curves on the other part of the line have been eased off on a plan introduced by Mr. Fulton—who is engineer of the line, as well as Locomotive Superintendent—being joined to the straight by a length of lesser curvature. The superelevation has also been made considerable, with a view to providing for high velocities.

The passenger cars run were built by the Gilbert Car Mfg. Co., of Troy, N. Y. The train was, therefore, a thoroughly American one.

The same engine, when subsequently tested with heavier loads, maintained a speed of 20 miles an hour up a grade of 1 in 100 with a load of 130 tons, and 16 miles an hour up 1 in 57 (1.75%) with 120 tons. All these results are regarded as extremely satisfactory, and have tended to give American engines a very good name in New Zealand.

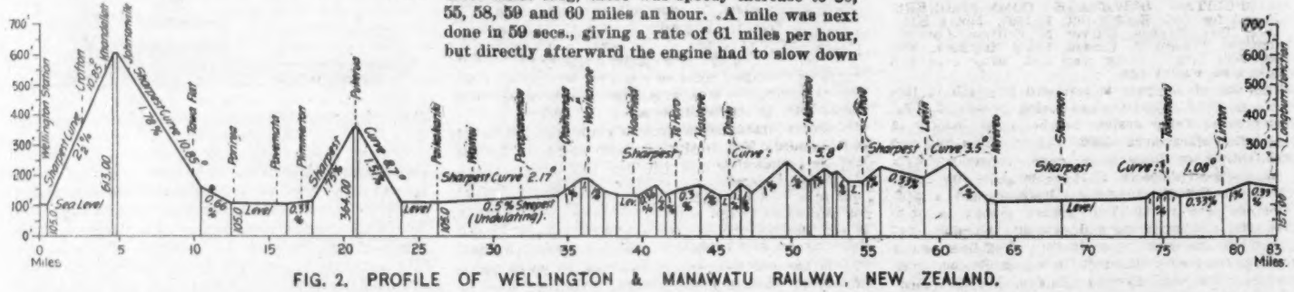


FIG. 2. PROFILE OF WELLINGTON & MANAWATU RAILWAY, NEW ZEALAND.

PERSONAL.

Mr. L. H. Clarke, City Engineer of Chicago, has resigned.

Mr. M. Malbouhan has opened an office in the Opera House Building, Chicago, to carry on a general practice in civil engineering.

Mr. Hunter McDonald has been appointed Chief Engineer of the Nashville, Chattanooga & St. Louis R. R., vice the late Col. R. C. Morris.

Mr. R. S. Woodward, of the U. S. Coast and Geodetic Survey, has been appointed Professor of Mechanics in the Columbia College School of Mines.

Mr. Victor Colliau, inventor of the Colliau cupola and furnace, and of other machinery for iron working, died at Detroit, Mich., Jan. 18, at the age of 66.

Mr. Simeon R. Billings, the new Railroad Commissioner of Michigan, has assumed the duties of his office. Mr. Robert Laughlin continues as Deputy Commissioner.

Mr. C. F. Brotherton, Superintendent, and Mr. B. F. Tibbitts, Chief Engineer of the Kansas City, Wyandotte & Northwestern R. R., have resigned, and the positions have been abolished.

Mr. E. C. Palmer, ex-mayor, and Mr. Geo. H. Brown have been appointed as members of the newly instituted Board of Public Works of Sioux City, Ia. The board has but two members.

Mr. Henry S. Codman, landscape architect, and member of the firm of F. L. Olmsted & Co., died at Chicago, Jan. 13. He was engaged as Landscape Architect for the World's Columbian Exposition.

Mr. Theodore Voorhees, M. Am. Soc. C. E., has resigned his position as General Superintendent of the New York Central & Hudson River R. R., to accept that of First Vice-President of the Philadelphia & Reading system at a salary of $15,000.

Messrs. Thomas Gahan, of Cook County; Charles F. Lape, of Sangamon County, and W. S. Cantrell, of Franklin County, have been appointed Railroad and Warehouse Commissioners of Illinois. Mr. Lape is Master Mechanic of the Springfield shops of the Wabash R. R.

Mr. W. H. Starr, Superintendent of Transportation, New York, Lake Erie & Western R. R., has resigned to become General Manager of the North Hudson County R. R., which controls the street car lines in Hoboken, N. J., and the elevated cable road from the Hoboken Ferry.

Prof Wm. H. Burr, elected in August last to take charge of the department of engineering at the

Lawrence Scientific School, Harvard, has been elected this week Professor of Civil Engineering in the Columbia College School of Mines, from which we infer that the effort to put new life into that unfortunate school has not been so hopeful in results, so far, as we had hoped and expected.

Mr. E. H. Beckler has resigned the position of Chief Engineer of the Seattle & Montana Ry., Chief Engineer of the Montana Central Ry., and Chief Engineer of the Pacific Extension of the St. Paul, Minneapolis & Manitoba Ry., all being parts of the Great Northern Railway system. Construction work on these various lines is practically completed, and the engineer's office at Helena was permanently closed Jan. 18.

Mr. Eckstein Norton, formerly President of the Louisville & Nashville R. R., died at New Brighton, N. Y., Jan. 12. He was born in Russellville, Ky., in 1831, and in 1855 he made a contract with the Illinois Central R. R. to forward its freight along the Ohio and Mississippi rivers. He organized the New Orleans & Ohio R. R. in 1870, and consolidated it with the Mississippi R. R. under the name of the Paducah & Memphis R. R. In 1884 he was appointed Vice-President of the Louisville & Nashville R. R., and President in October, 1886, resigning that position in August, 1891.

Mr. Egbert Judson, a well known California business man and a prominent factor in the powder interest, died in San Francisco, in the early part of this month, aged about 81 years. Mr. Judson went to California in 1850, and in 1855 became interested in the San Francisco Chemical Works, and from this time continually enlarged his business interests. He is said to have been the first man to successfully carry water across a ravine in a wrought-iron inverted siphon, under 900 lbs. pressure, for hydraulic mining, and he was one of the chief owners of the North Bloomfield mines. He was one of the originators of the Giant Powder Co., the first to manufacture high explosives on the Pacific coast. He invented and manufactured the Judson powder for bank-blasting, and organized the Judson Dynamite & Powder Co. He left an estate of about $3,000,000.

NEW PUBLICATIONS.

METROPOLITAN SEWERAGE COMMISSIONERS: Report for Year Ending Oct. 1, 1893. Hosea Kingman, Tilly Haynes, Harvey N. Collison, Commissioners; Howard A. Carson, Chief Engineer. 8vo, pp. 146; large folding map and many cuts and half tone engravings.

The work of the year is reviewed in detail in this report, many fine illustrations being presented. The Charles River Valley system has been completed, and in operation since April, 1892, and all the cities and towns within its limits have made connections with it. This system disposes of the sewage of Waltham, Watertown, Newton, Brighton, Brookline and a part of Boston. The North Metropolitan system is well under way, being completed, except pumping station and siphons, from the southerly end of Deer Island through the island, Winthrop, and East Boston, with portions in Chelsea, Everett, Malden, Melrose, Medford, Charlestown, Somerville and Cambridge. At the time the report was made it was expected that work would soon be started in other towns.

ASPHALT AND CEMENTS, Sixth Annual Report of the U. S. Inspector of, for the fiscal year 1891-92. Washington, D. C.; 8vo; pamphlet; 60 pp.

The greater part of this report is devoted to Trinidad pitch and its occurrence, origin, nature and commercial application. "The Reports of Consuls of the United States," No. 145, Oct., 1892, contains a still more detailed report upon this subject by U. S. Consul Pierce, of Trinidad.

TIPS TO INVENTORS; telling what inventions are needed, and how to perfect and develop new ideas in any lines. By Robert Grimshaw, Ph. D., M. E., author of "The Steam Engine Catechism," "Pump Catechism," "Boiler Catechism," etc., etc. The Practical Publishing Co., N. Y.; 12mo; 84 pp.; $1.00.

The very best and kindest of all tips to the class of inventors to which this book is addressed can be condensed in the single word "Don't." After reading this volume, which is no long task, the whole book containing only about as much printed matter as three or four pages of this journal, we are inclined to think that the next advice, to those who will not accept the first, is: Beware of such advice as this book gives concerning the profitable lines on which the ordinary inventor may work. Most of the inventions which he suggests have already been made and carried to such perfection that the few men who can improve them need no "tips." For example, among the things of this superficial sort on which the author advises inventors to work, are: Ice machines, railway brakes, safety boilers, car heaters, typewriters, pyrometers, dredges and street pavements. He also advises inventors to work on processes for storing the power of lightning during concer and consumption, extracting gold from clay, and other chemicals on which "mechanical geniuses" are apt enough to waste their time without finding encouragement in books. The last half of the book, on perfecting, developing and selling patents, is very good when compared with the matter preceding it.

FOREIGN COMMERCE OF THE UNITED STATES for the year ending June 30, 1892. Report of Chief of Bureau of Statistics. Pub. doc., pp. 131.

This report is always interesting to examine, because of the bird's-eye view of industrial changes for many years past which its tables afford. A few of the more salient facts given in it are as follows:

The fall in export prices of agricultural staples has been quite steady since 1885, as the following abstract of a much larger table will show:

	1855.	1872.	1882.	1892.
Corn, cents per bu.....	80.	70.	67.	55.
Wheat, cents per bu.....	160.	147.	119.	103.
Cotton, cents per lb.....	8.7	19.3	11.4	8.7
Sole leather, cents per lb.	....	....	20.6	15.6
Illum. oil, cents per gallon.	....	24.9	9.1	5.9
Bacon, cents per lb.....	8.4	8.6	9.9	8.1
Lard, " " "	10.3	10.1	11.6	7.2
Pork, " " "	7.3	7.2	9.	6.0
Salt beef " " "	8.8	7.	8.5	5.7
Butter, " " "	18.1	19.4	19.3	16.3
Cheese, " " "	10.6	11.7	11.	9.4
Eggs, cents per dozen...		20.3	19.2	17.7

Lest this table should be too hastily taken as proof of the "appreciation of gold," it may be well to note that improvements in agricultural machinery and fall in freight rates are alone sufficient to explain changes of this magnitude; and that products like human labor, which are still produced in the "good old ways" of 1855, have by no means fallen in proportion, but, rather, have risen in price.

The exports of 1892 ($1,016,000,000) were about one-eighth greater than the highest on record, owing to the exceptional foreign demand for our food products, and were just about ten times the average of 1845-6, and twice the average of 1873-6. The same is very nearly true of our imports. Gold exports have been very heavy lately ($68,500,000 net in 1891-2) and silver exports very small ($17,000,000).

Four pages of tables, showing in brief the progress of our trade with every country in the world since 1860, and the statistics given for the wheat crop of the world, are of very great interest, but can hardly be abstracted.

The percentage of domestic manufactures exported has increased only from 12.76% in 1860 and 15.00% in 1870, to 15.61% in 1892; a very small relative increase though the absolute increase has, of course, been large.

It is a fact not generally known that, in addition to our reported totals of immigrants, an increasing number, which in 1891 was officially reported at 105,213, arrive at Canadian ports en route for this country, and are not included in our immigrant statistics, being nearly 20% of the whole number. In addition to this, the native immigration from Canada and Mexico is not included. The Mexican immigration is very small, but the Canadian is 40,000 to 50,000 per year.

The American shipping entered from foreign ports in 1892 was 3,746,651 tons, or only 21% of the whole, being substantially the same as since 1878. The amount is considerably larger than was ever entered prior to 1861, when the American foreign entries were over 70% of the whole, and is as great as the largest entry of foreign tonnage prior to 1870.

AMERICAN WATER-WORKS ASSOCIATION: Report of Meeting at New York, May 17 to 20, 1892. Peter Milne, New York, Secretary. 8vo, pp. 232; folding plate.

The proceedings of this meeting were reported in our issues of May 19 and 26, 1892, some of the papers being abstracted or presented in full in those and succeeding issues.

TRADE PUBLICATIONS.

CREOSOTED TIMBER.—Eppinger & Russell Creosoting Works, Long Island City, N. Y. 8vo, pp. 30, illustrated.

The method of timber preservation by treatment with dead oil of coal tar, or creosote, is well known and extensively used. This pamphlet gives particulars and illustrations of treated and untreated ties, piles, paving blocks, etc., and the Macdonald subway electrical conduit made of creosoted timber, and used in Brooklyn, Philadelphia, etc.

BLOCK SIGNALING.—Mozier Safety Signal Co., Galion, O.; 8vo.; pp. 19; illustrated.

This pamphlet contains reprints of articles describing the Mozier block system for single track, which is worked by the operators in accordance with telegraph oreds from the dispatcher. A three-position semaphore is used, and a safety signal device so arranged that whenever the lever is fastened in any other position than at "danger" the operator cannot work his telegraph key. He cannot, therefore, answer a call or acknowledge an order unless the signal is at danger. The system is in use on the New York, Pennsylvania & Ohio R. R., and is being applied on other roads.

HEATING AND VENTILATING APPARATUS, ETC.—Illustrated general catalogue. Buffalo Forge Co., Buffalo, N. Y. 8vo, pp. 288; illustrated.

This is a very complete descriptive catalogue of the various machinery, tools and apparatus manufactured by the company, with tables of dimensions, power, capacity, etc. It includes steel plate steam and pulley fans, horizontal and upright steam engines, hot blast steam heating apparatus, steam coils, blowers and exhausters, and disk ventilating fans. Particulars are given of applications of the various heating and ventilating appliances in shops and buildings. It also includes hand and power blacksmith drills, punch, shear and bar cutters, stationary and portable forges, etc.

WOOD-WORKING MACHINERY. Catalogue of the John A. White Co., Dover, N. H.

A superbly printed and illustrated catalogue of 74 pages, describing the various wood-working machines manufactured by this company.

SOCIETY PROCEEDINGS.

WESTERN RAILWAY CLUB.—At the meeting on Dec. 20 Mr. Barr's paper on "Lubrication" (Eng. News, Dec. 1, 1892) was discussed, and some interesting figures were reported. Mr. Waitt, of the Lake Shore & Michigan Southern, said that during the year 1891 the average cost of lubricating oil on that road was 9 cts. per thousand car miles. About two years ago he began investigation to see what could be done to improve the quality and decrease the cost of lubrication. He required reports to be made of all cases of hot boxes requiring repacking of a box, replacing of a brass, or which caused delay of a train. He found the chief causes of hot boxes to be lack of oil or waste and worn out brasses. As a result, orders were issued requiring the packing to be removed from boxes of every car going to shop for repairs. The packing was sorted, and any which was good was soaked in oil at least 48 hours before being used. It was also found that hard spots in the brasses were another common cause of hot boxes. These hard spots are due to lack of homogeneity in the brass, the copper and tin not being alloyed properly. To remedy this the plan of remelting was adopted with good success. He had also substituted wool waste for cotton waste in passenger service with satisfactory results. The wool waste seems more elastic than the cotton, and does not get compressed so hard in the back of the box. Although the wool waste costs more than the cotton per pound, it goes so much farther that the actual cost per car is no greater. The following shows the results obtained on the Lake Shore & Michigan Southern in 1890 and 1891:

	1890.		1891.	
	Frt.	Pass.	Frt.	Pass.
Oil used, galls.....	212,965	28,041	26 ,097	35,772
Car mileage (1 = 1 000).	207,700	23,203	203,828	24,403
Ave. cost per 1,000 car miles.	8 cts.	18 cts.		
Ave. hot boxes per mo. per 1,000 car miles...	.046	.028	.039	.027

In 1892 a change was made to oil of a better quality, and the consumption per thousand miles in freight service dropped from 0.912 gallons to 0.639 gallons, or about 30%. In passenger service there was a slight increase in the consumption, but there was a material decrease in the number of hot boxes.

Mr. Godfrey W. Rhodes called attention to the fact that comparisons between different roads may be misleading if the car mileage is not made up on a uniform basis. On the C., B. & Q. empty car mileage is reduced one-third to convert it to loaded car miles, and all grease and tallow used in cooling hot boxes is accounted for in the cost per thousand miles. The price of oil, too, makes a great difference, as may be seen by the following comparison between the cost of lubricating locomotives per 1,000 miles run and the average miles run per pint of oil at different times:

	Average cost of lubricating locomotives per 1,000 miles run.	Price of oil per gall.	Average miles run by a locomotive per pint of lubricating oil.
1890.....	92.25 cts.	18 cts.	24.40
1891.....	24.72 "	5½ "	23.14
Jan., 1892....	30.38 "	6½ "	2 .29
June, 1892....	23.01 "	4⅞ "	12 82

With regard to freight cars, the cost per 1,000 miles on the C., B. & Q., on the loaded car basis, is 9.77 cts. for oil alone, and 11.32 if tallow and grease is included.

Mr. Barr called attention to the fact that other causes than poor lubrication, such as heavy traffic, overloaded cars, and dry and dusty weather, might cause an increase in the number of hot boxes. While dry waste is often given as the cause of hot boxes, it is more frequently the result. He had dropped the use of wool waste, and found benefits thereby, and also by the use of brasses filled with a soft metal composed of 15 parts antimony and 85 parts lead, while Mr. Waitt reported exactly the contrary experience. One good feature of cotton waste is that it prevents the oil from running out at the back of the box better than wool waste.

President Lewis said he had found an average consumption of cylinder oil on locomotives of 65 miles per pint, but as an experiment, with a good locomotive and a careful engineer, a run was made of 1,720 miles with one filling of the oil can, or about 800 miles per pint. At the conclusion of the trial the valves and cylinders were found in perfect condition.

Mr. Barr said that by way of experiment he had

run a 12-wheel passenger car 9,000 miles at a cost of less than 5 cts. per 1,000 miles for lubrication.

At the close of this discussion Mr. Rhodes brought up the matter of the use of iron dead-woods with M. C. B. couplers. A few years ago they were in use on nearly all the Eastern roads, but in the West they were called "mankillers," and there was much prejudice against them. Now, however, with the increase in automatic couplers the opposition is dying away, and the advantages of the dead-woods are being recognized. For example, a construction train fitted with dead-woods and M. C. B. couplers has been running three years on the C., B. & Q., and in all that time there has been but one broken drawbar in the train. An objection to the use of deadwoods is that the cars may not couple automatically on curves; but if the curve is so sharp that this is the case, a link can be used. But just at this time some of the principal Eastern lines, the Pennsylvania, the New York Central and the Michigan Central, are abandoning the use of the dead-woods. Mr. Barr said that one objection to the use of the large cast iron dead-woods is the danger of derailment if they get loose and fall on the track.

OHIO SOCIETY OF SURVEYORS AND CIVIL ENGINEERS.—The fourteenth annual meeting was held at Hotel Chittenden, Columbus, O., Jan. 17, 18 and 19, the President, Mr. C. H. Burgess, in the chair; Mr. Chas. A. Judson, Secretary and Treasurer. A number of important matters were discussed by the society, the questions arousing greatest interest being the improvement of methods of surveying, the making of roads and sewage disposal and water supply.

Mr. W. A. Ginn, of Sidney, read a paper entitled "Account of a Survey of Public Land." This was illustrated by some very neat and well made plans and records as kept by Mr. Ginn. A paper on "How I Make a Survey" was read by Mr. Elmer E. Harvey, London, O.

The report of the Committee on Highways stated that as it will be many years before even a small part of the country roads will be improved by graveling or macadamizing, it would be well to urge the adoption of some plan to keep the ordinary dirt roads from becoming impassable for three or four months of each year. This might best be accomplished by the use of broad tires on all vehicles for heavy loads, and to avoid imposing compulsory expense upon the farmers it was suggested that, as in Michigan, a rebate of half the road tax might be made to men using tires of over a certain width. The paper by J. M. Harper on "The System of Laying Out, Constructing and Maintenance of Road Improvements in One of the River Counties of Ohio" showed very clearly the way in which county officials interfere with the proper laying out and construction of roads, through ignorance and desire for personal rather than public benefit. The experience recorded in this paper is that of many engineers in country districts. The paper by J. F. Brown, on "Location of Country Roads," showed the difficulties encountered in laying out roads from old records, and the troubles arising from the variation and unreliability of the magnetic needle. He proposed to establish a meridian in each township, and to provide by statute that surveys must be connected with these meridians by angles observed with a transit. He uses three monuments at intersections, one as the center line and one on each side line of the road. Where stone is not plentiful, or in hard ground, iron bars make good monuments. For the width of country roads he recommended a minimum of 60 ft.

Messrs. John B. Weddell and L. E. Chapin also took up the subject of highway construction, the former reading a paper on "The Pike Roads of Galion and Vicinity," and the latter giving some interesting notes on "Brick Pavements of Canton."

A paper entitled "Panorama of Bucyrus" was read by H. L. Weber, describing the location of the city, its sewer system (including oval pipe sewers, which have proved very satisfactory) and its water supply from artesian wells and fire cisterns. The street paving and local manufacture of paving brick were described and reference made to the dredges manufactured by the Bucyrus Steam Shovel & Dredge Co., including the machine described and illustrated in our issue of Aug. 4, 1892.

Mr. Brown, of Bellefontaine, O., read a paper strongly advocating the use of lime with Portland cement for producing a mortar of ordinary strength and of quick hardening qualities. He claimed that by such a mixture a mortar can be produced better and cheaper than natural cement mortar. The "Report of the Committee on Drainage" was presented by Mr. S. F. Moore. The committee sent our circulars to 86 county surveyors to determine how much drainage work was being carried on in the state, but only 12 replies were received. Mr. Moore explained what he calls his "Inlet System of Tile Ditching," which seemed to be one of merit, especially where there is a large quantity of surface water.

Mr. J. B. Strawn, of Salem, O., read a paper entitled "An Acceptable Water Supply," the introduction of which discussed in a general way the quality of water supplies. The main part of the paper described the water-works of Willoughby, O., recently built. The supply for these works is taken from a well and gallery in gravel about 150 ft. from the east and about 400 ft. from the west branch of the Chagrin River. The well is 30 ft. diameter and 12 or 13 ft. deep, lined with 18 ins. of brick, the lower 18 ins. of which were laid dry. The gallery connects with the reservoir and is 100 ft. long, 5 ft. wide and 5 ft. high. It is also lined with brick, with the lower 18 ins. laid dry, and is covered with a brick arch. The reservoir is covered with an 8-in. brick domed roof. Aside from keeping the water in the well and gallery from the light, it was desirable to cover them for protection against ice gorges at times of winter floods in the river. Water is pumped to a reservoir 61 ft. in diameter and 16 ft. deep, walled with vitrified brick in cement mortar, with its floor covered with 3 ins. of concrete and 1 in. of Portland cement mortar. The reservoir has a capacity of 360,000 gallons, and is covered with a conical shaped shingle roof. The shingles were dipped in white paint before laying and after laying received a second coat of white paint.

Mr. Strawn also read a paper describing a water main laid on an iron bridge across the Mahoning River, at Niles, O. The bridge is 186 ft. long and the pipe on the bridge is of wrought iron with screw joints. The pipe is laid between the wooden floor joists of the bridge, which are 12 ins. deep and 16 ins. c. to c. A box was formed around the pipe by nailing a bottom in between the joists. The pipe was laid on tarred roof felting. The space between the pipe and the joists was packed with sawdust and the felting brought up each side and across the top, with an extra thickness over the top of the pipe, just beneath the floor. At each end of the bridge the junction with the pipe line was made with cast iron bends left unprotected.

Before the water-works were put in use the thermometer fell to 19° below zero, with no water being drawn from the system. The water in the pipe on the bridge did not freeze, nor did it freeze at the unprotected ends. Mr. Strawn asked in his paper why the water did not freeze, and propounded the theory that the difference between the temperature of water in the pipe on the bridge and the pipe in the earth kept up a circulation of and between the top and bottom layers of water in the pipe on the bridge.

Mr. John W. Hill, M. Am. Soc. C. E., read a paper on "Sewage Disposal and Water Supply," in which he pointed out some of the dangers surrounding the present mode of sewage disposal, especially as affecting public water supplies. Mr. Hill described briefly various methods of sewage purification, and the examination of water supplies with a view to determining their quality. Speaking of the growth of urban population in this country, Mr. Hill said:

> The growth of the city and the multiplication of towns is followed by this contamination of lakes and streams, which sooner or later must become the sources of water supply for these and other towns. And, unless prudential methods of operation and rigid statutes for the disposal of sewage in some other manner than by its delivery into running streams and currentless lakes shall be adopted by all the states it is only a question of time until water for public supply, obtained in a wholesome condition at its source, will be a rare and costly commodity.

In the discussion following this paper Mr. L. E. Chapin, M. Am. Soc. C. E., gave a description of the sewage purification works which he has designed for and which are now being built at Canton, O. Chemical precipitation will be used, but the full details of operation are not yet decided.

Mr. F. P. Burt, associate editor of Engineering News, was invited to take part in the discussion, and gave some statistics of the use of sewage for irrigation purposes, and notes on a system of intermittent filtration proposed for Plainfield, N. J.

The society unanimously agreed to hold the annual meetings hereafter in different parts of the state instead of going always to Columbus, as heretofore. The next meeting will be in Cleveland, O., at the invitation of the members from that city.

The exhibits at the meeting were chiefly surveying and drafting instruments. Veit & Perfler, Columbus, O., showed some transits and levels of excellent workmanship. A large number of steel band chains of superior design were shown by Fred. J. Sager, Columbus, O. The system of marking these tapes (by a copper plate firmly attached to the steel) is a good one, where divisions less than one foot or one link apart are not required. The detachable handles, pin-guards and reels are also worthy of notice. B. E. Sawyer, of Athol, Mass., sent for exhibition a combination protractor, T-square, straightedge and section line of seemingly more than average merit. Although very long, the blade of the straightedge is very rigid, as the head runs against a metal edge clamped to the drawing-board. The protractor can be arranged to fit the straightedge by a spring and can also be clamped to it. By moving the protractor along the blade of the straightedge, and moving the straightedge along the metal guard, a line in any required direction can be plotted on any part of the drawing.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—In our issue of Jan. 19 we gave a report of the business session of the annual meeting held Jan. 18. In the election of officers the number of votes in each case was as follows, the total number of votes cast being 434: President, Wm. Metcalf, 433; Vice-Presidents, E. L. Corthell, 427; Charles Macdonald, 432; Directors, W. S. Pope, 433; F. P. Stearns, 432; O. H. Landreth, 432; J. F. Crowell, 432; H. G. Prout, 431; J. T. Fanning, 382; Secretary, F. Collingwood, 431; Treasurer, John Bogart, 419. In the evening Mr. Wm. D. Kelley lectured upon the work on the survey for the proposed intercontinental railway to connect the railways of the United States with those of the South American republics. The lecture was illustrated with many stereopticon views of the country. As a result of the Pan-American Congress held four years ago the Intercontinental Railway Commission was organized a year later, consisting of representatives of the republics interested, and decided to put survey and exploration parties in the field. Each country appropriated $1,000 per 1,000,000 inhabitants. There were three parties; one working south from Mexico through Central America, a second from Quito, in Ecuador, north to Panama, and a third south from Quito 1,700 miles to the southern boundary of Peru, near Lake Titicaca. The railway will have to be built from Guatemala to the southern end of Peru, connecting existing lines to the United States and the Argentine Republic. Mr. Kelley was of the third party, which proceeded as far as Cuzco. The route followed the elevated plateau of the Andes, passing through the most healthy and most populated country. A coast line on the western foothills would be largely in desert, while a line on the eastern or interior slope of the mountains would be entirely away from civilization, and in an unhealthy country.

A stadia survey was made, using a 30-ft. rod with large white flag on the top, and taking sights of 2,000 to 6,000 ft. The pole was in three sections, the bottom 14 ft. being of T section to withstand wind pressure, and the lower 5 ft. subdivided for short readings. There is not enough timber for construction purposes, ties or telegraph poles. The railway ties in that region are of lignum-vitae and cost $1.20 each, while the poles are usually of metal. There is sufficient stone. The principal obstacles encountered are the quebradas or lateral canyons, necessitating long detours to pass or traverse them. The maximum grade allowed was 4%, and the longest tunnel will be 1½ miles long. The highest and lowest elevations on the line are 15,000 ft. and 2,400 ft., respectively, above sea level.

On Jan. 19 a large party of members proceeded by steamer and cable car to the 155th St. viaduct and Seventh Ave. drawbridge over the Harlem River, which were described and illustrated in our issue of May 26, 1892. The viaduct is completed, and work is in progress on the foundation for the bridge piers. The viaduct will connect Washington Heights with the elevated railway on Eighth Ave. and with the opposite side of the river. The bridge will replace the old Macomb's Dam bridge. To make room for the present construction, and to provide a temporary crossing of the river near this point, the old wooden draw has been moved bodily upstream to 166th St. (News, Aug. 18, 1892). The viaduct is 1,400 ft. long, and carries a roadway 40 ft. wide between curbs, with two sidewalks, each 10 ft. 6 ins. in width, on a grade of 4¾%. The floor consists of ⅜-in. buckle plates covered with bituminous concrete, with 6-in. granite block-paving for the roadway, and asphalt for the sidewalks. The columns near the upper abutment are founded on rock, and the others on piles.

The draw will be 408 ft. 6 ins. c. to c. of end pins, and 43 ft. 6 ins. c. to c. of trusses. The eastern approach is formed by two 100-ft. lattice deck spans, one 219-ft. riveted through span over the right of way of the New York Central R. R., and nine lattice deck spans, each 98 ft. 10 ins. c. to c., east of that road. These latter spans are on a curve of 1,500 ft. radius and lead to an abutment at 161st St., which is crossed overhead. From this point an embankment 450 ft. long between retaining walls will carry the approach to the junction of 162d St. and Jerome Ave. An approach is also contemplated from Ogden Ave. The viaduct and bridge are built from plans and specifications of A. P. Boller; W. G. Triest is assistant engineer, and P. K. Yates general inspector. The viaduct is under the jurisdiction of the Department of Public Works, and the bridge and eastern approaches under that of the Department of Public Parks, Martin Gay acting as engineer for both departments. The contractors are as follows: viaduct, Herbert Steward, with the Union Bridge Co. as sub-contractor for the metal work; draw and eastern approach, Passaic Rolling Mill Co., with Steward & McDermott as sub-contractors for the masonry. The pneumatic work is sublet to Sooysmith & Co. The estimated cost of the viaduct is $650,000, and of the draw and eastern approaches $1,250,000.

The party returned to the steamer, where lunch was served, and proceeded to the shops of the De La Vergne

Refrigerating Machine Co., at the foot of E. 138th St., where, by the courtesy of Mr. E. V. Clemens, Superintendent, facilities were given for the inspection of the works. There are four large buildings, the main buildings having three stories with floors each 55 × 180 ft. The works manufacture ice and refrigerating machinery exclusively. In the machine shops there are many special machine tools and appliances, original and exclusively used by this company. The pipe shop, 95 × 125 ft., is devoted to the making up of the pipe work and patented ammonia joints, the pipe making a circuit of the shop from its entry as it arrives from the mills to its being run out on cars and made up into necessary combinations from drawings. The heavy machinery department is devoted to fitting up Corliss and compressor cylinders, and the light machinery department to connecting rods and smaller details used on the machines. On the upper floor of No. 1 building are the pattern shop and the sheet iron department, where the ice cans in which artificial ice is frozen are made, etc. The lower floor of No. 2 building is a storehouse for machines ready for shipment. The second floor is devoted to manufacturing fittings and ammonia cocks; the tool room is also located on this floor; and the third floor contains the carpenter shop, and storeroom for small details.

The erecting shop contains the largest of the machine tools, including a 10 × 10 ft. planer, 15-ft. boring mill, etc. The tools in this shop, including a 15-ton capacity Morgan crane, are run entirely by electric motors. Each tool is connected up individually to its own motor, which is of a size and capacity equal to the requirements. A series of tests is being made to ascertain the comparative cost of maintenance, etc., as compared with that of the ordinary arrangement with line shafting, etc. The engine room contains a cross compound Corliss engine for running the machinery in shops Nos. 1 and 2; also a vertical Corliss engine, furnishing power through two 40-HP. Thomson-Houston generators to the erecting shop tools and crane. The arc and incandescent lighting dynamos are also located here. Among the completed machines in the erecting shop were a 220-ton machine for Louisville, Ky., and there are under construction a 300-ton machine for the Pabst Brewing Co., Milwaukee, Wis., also a 75-lb. refrigerating machine with a 30 × 30-in. Corliss engine, with complete plant and building of proportionate size, in course of construction for the United States Government. The boiler house contains six 150-HP. Manning boilers. The manufacture of anhydrous ammonia was one of the interesting processes observed.

The offices are well arranged and well lighted; on the third floor are the drafting room and dining room. In the fourth floor, which is in the tower, blue prints are made; electric arc lamps being used to print during rainy or dark days.

The following is an abstract of the report of the Board of Direction for the year ending Dec. 31, 1892:

The changes in membership are fully shown in the following table:

	Jan. 1, 1892.			Jan. 1, 1893.			Losses.				Additions.		Totals.	
	Res.	Non-res.	Total.	Res.	Non-res.	Total.	Transfer.	Resignation.	Dropped.	Death.	Transfer.	Election.	Loss.	Gain.
Hon. Mem..	4	1	5	6	2	8	..	..	..	1	a2	2	1	4
Cor. Mem..	..	3	3	..	3	3	..	..	..	..	..	..	..	..
Members. .	190	918	1,108	194	940	1,134	2	2	6	12	b3	45	22	48
Assoc. Mem.	9	40	49	20	89	109	..	..	..	..	c19	41	..	60
Associates...	19	44	63	22	47	69	1	1	..	..	d1	7	2	8
Juniors. . ..	50	162	221	74	164	238	23	2	3	2	1	46	30	46
Fellows. . .	16	33	49	14	34	48	..	..	..	2	..	1	2	1
Subscribers..	8	30	38	8	27	35	..	..	..	3	..	..	3	..
Totals. .	305	1,231	1,536	338	1,306	1,644	26	5	9	20	26	142	60	168

a Members. b One Associate and 2 Juniors. c All Juniors. d Junior.

It will be seen from the table that the net increase in the membership during the past year has been 108. Applications for membership have been acted upon by the Board during the year as follows: Passed to ballot as member, 53; passed to ballot as associate member, 65; elected honorary member, 4; elected junior, 47; elected fellow, 2; total, 171; awaiting action, 18.

There have been rejected by the Society one candidate for membership and one for associate member.

The subject of membership cannot be passed without brief mention of the great loss sustained by the society and the profession at large in the death of two of its past Presidents during the year. Past President and Honorary Member James B. Francis was identified with the society from the date of its incorporation in 1852. His reputation as an engineer was world-wide, and his best thought and judgment in professional matters were freely given, both to individual members and the society at large. Up to the last he delighted to take part in its meetings, and he will be greatly missed from future gatherings of our members. Past President William P. Shinn became a member of the society in 1869, and interested himself most thoroughly in every movement for its advancement; he will long be remembered for his earnestness of purpose, clearness of comprehension, and bold advocacy of whatever he thought to be for the best interests of the society. In addition to these the losses by death during the year 1892 have been eleven members: H. Wadsworth Clarke, George C. Dickinson, John H. Morton, Edward M. Reed, John Whitelaw, Andrew D. Whitton, George F. Wright, Joseph N. DuBarry, H. Stanley Goodwin, William W. Hegeman and Robert C. Morris; two juniors, Elijah P. Butts and Arthur H. Wood; and two fellows, Sidney Dillon and Frederick O. Norton.

The enlarged Board of Direction under the new constitution was elected at the last annual meeting. There have been 14 meetings of the Board; the average attendance has been 13; the average attendance of non-resident members has been four (ranging from one to nine, and at no time has the Board lacked a quorum. The constitution provides for the appointment of two new officers, an assistant secretary and librarian, and an auditor. To the first of these offices, Charles Warren Hunt, M. Am. Soc. C. E., was appointed April 5, 1892, and entered at once upon his duties. Thomas B. Lee, who has for many years been Chief Clerk of the Society, was appointed Auditor in March, and has since had entire charge of the accounts of the Society.

A complete rearrangement of the books in the library has been effected, as well as a careful verification and correction of the card catalogue. The number of titles now on the shelves is over 16,000, and while it is very difficult to place a valuation on many rare books and manuscripts, some of which could not be replaced, it is believed that if the cash value of the library were placed as one of the assets of the society, $17,000 would be a very conservative estimate of its worth; it is insured for $15,000. A list of the books sufficiently complete for identification in case of loss by fire has been made, and placed in a safe deposit vault.

The Board reiterates here what has been already said in circulars, that, this being a reference library, it is most desirable that copies of reports of every kind bearing even remotely upon engineering subjects should find a place on its shelves. Every member should feel it a duty to contribute to the library copies of all such reports, whenever possible, and to inform the Secretary of other desirable material which may be obtained. The importance of attention to this request will become increasingly evident in the future. There are yet some sets of municipal and railroad reports which are incomplete and should be filled up. It not infrequently happens that reference is made to this library, after search elsewhere has failed, for information as to the early history of projects or enterprises which have since become important. No legacies of books have been received during the year, although no better disposition of an engineering library can be made.

The additions to the library from all sources have been: Bound volumes, 149; pamphlets 417; maps, 221; photographs, 5; specifications, 301; total, 1,093.

The society was represented at the International Congress on Internal Navigation, held at Paris July last, by Edward P. North, Estevan A. Fuertes, George H. Ely, William Watson, Cady Stanley and Cyrus B. Comstock. The delegation was well received, and took an active part in the proceedings. Professor Fuertes was made First Vice-President of the Economic Section. A full set of the printed proceedings of the Congress has been received and placed in the library.

The Board has devoted much time to the discussion and arrangement of matters connected with the proposed engineering congress to be held at Chicago during the first week in August, under the auspices of the World's Congress Auxiliary. The Executive Committee of the Engineering Societies having decided that this society should be asked to contribute $3,000 as its proportionate share of the amount needed for the maintenance of suitable rooms as a headquarters at Chicago for visiting engineers, our membership has been called upon for subscriptions, and the full sum has been secured and will be paid over as it may be needed. Early in the year this society was requested by the General Committee on Engineering Congresses of the World's Congress Auxiliary of the Columbian Exposition to undertake "the work of the organization and management of Division A, Civil Engineering," to be held at Chicago in the summer of 1893. After proper consideration by the Board of Direction it was determined to accept the duty thus tendered, and to make the Congress the occasion of the society's annual convention. In accordance with this arrangement invitations to co-operate in obtaining papers of general interest to the profession have been sent to all the leading engineering societies in this country and abroad. Courteous acknowledgments of these invitations have been made, and enough papers have been promised to make a very full programme for the meeting. Many of those who promise papers have an international reputation, and it is confidently anticipated that the matter presented will be of great value.

The social reception of visitors from those societies which entertained members of this and other societies for 1889 has been intrusted to a committee composed of members of this and of the other three national engineering societies. Whatever this joint committee decides to do is to be accomplished without cost to this society.

In the last annual report a recommendation was made by the Library Committee, that a semi-monthly publication be issued containing such information relative to meetings, papers and other matters as had formerly been sent out by circulars, postal cards, etc. The Board of Direction ordered the printing of such a publication, and the first number was issued April 14. It has since been continued regularly except during two of the summer months.

The Publication Committee recommended, and the Board after much discussion adopted, a new policy in relation to the issue of papers in the "Transactions." Papers are now printed in the "Transactions" as soon as possible after presentation to the society. Ample time is given after distribution to all members, for discussions, which are subsequently printed. The object is twofold: 1st. To secure the prompt printing of all papers; 2d. to give every member an opportunity to take part in the discussions.

It has become evident to the Board that many of the members do not sufficiently consider the duty they owe to our profession and to the society, in presenting papers describing their work. The first of the objects named in the constitution as a reason for the existence of the society is "the advancement of engineering knowledge and practice." If these words mean anything, when a person joins the society it becomes his duty to do his share of this important work; and the society can never reach its highest usefulness until its members appreciate and act upon this obligation.

There have been printed in the "Transactions" during the year ending Jan. 1, 1893, 48 papers in 13 monthly numbers, covering 1,678 pages, illustrated by 208 cuts and 168 plates. The "Proceedings," containing minutes of meetings, memoirs, etc., have covered 248 pages.

The Board desires to impress upon the members the importance of promptly notifying the secretary of the death of any member, and of assisting in the preparation of suitable memoirs. These become in after years a part of the history of the profession, and are too important to be neglected.

At its meeting on Dec. 6, the Board of Direction took action on the question of the continuous publication of the list of subscribers of the Building Fund in the annual list of members. It was ordered that in future the names of those who had subscribed but not paid their subscription, be dropped; that the names of all who have subscribed to the enlargement of the society house shall thereafter be published as subscribers to the building fund, and that this list shall contain only the names of those who have subscribed $100 or more; provided, however, that the names of those whose subscription was less than that sum, but who shall hereafter make up the amount to $100, shall appear in the future lists.

During the year beginning Jan. 1, 1892, 20 meetings of the society have been held, one of which was the annual meeting held in New York, Jan. 20 and 21, and one was the annual convention held at Fort Monroe; 41 papers have been read and have been discussed orally or in writing by 264 persons.

The Norman Medal for 1891 was awarded to John R. Freeman, M. Am. Soc. C. E., for the paper on "The Nozzle as an Accurate Water Meter." The Rowland Prize for 1891 was awarded to William H. Burr, M. Am. Soc. C. E., for the paper on "The River Spans of the Cincinnati & Covington Elevated Railway Transfer and Bridge Company."

The following is an abstract of the report of the Auditor for the year ending Dec. 31, 1892:

Receipts.		
Balance on hand Dec. 31, 1891....		$5,660.58
Entrance fees.....	$3,065.00	
Current dues.....	18,475.12	
Past dues.....	943.08	
Dues for year beginning Jan. 1, 1893..	5,476.45	
Sales of publications.....	2,187.15	
Badges.	420.00	
Certificates of membership.....	155.55	
Advertisements.	1,202.00	
Interest on invest. bonds.....	1,186.33	
Compounding dues.....	575.00	
Fellowship fees.....	250.00	
Other sources.....	103.45	
		34,039.13
Total.....		$39,699.71
Disbursements.		
Interest on mortgage.....		$800.00
Taxes.		425.00
Publications.		15,230.17
Stationery and printing.....		1,278.18
Postage.		1,741.67
Library.		1,829.92
Salaries of secretary, assistant secretary and treasurer.		6,022.16
Convention and annual meeting.....		1,450.05
Janitor.		730.00
House supplies and furniture.....		207.98
Fuel.		256.00
Water.		17.55
Gas.....		141.73
Certificates of membership.....		81.05
Badges.....		430.00
Insurance.		120.00
Safe deposit.		10.00
Norman Medal and Rowland Prize.....		120.85
Treasurer's books and accounts.....		450.00
Work of committees.....		162.60
Repairs and betterments, society house.....		397.32
Other expenditures.....		473.80
Current business.....		2,723.35
		$35,098.47
Balance.....		4,601.24
		$39,699.71
Report of the Treasurer.		
Balance on hand Dec. 31, 1891....	$5,660.58	
Receipts Jan. 1 to Dec. 31, 1892..	34,038.13	
Payments of audited vouchers, Jan. 1 to Dec. 31, 1892.....		$36,690.97
Balance on hand Dec. 31, 1892, in bank and trust company.....		3,008.74
	$39,699.71	$39,699.71

COMING TECHNICAL MEETINGS.

CANADIAN SOCIETY OF CIVIL ENGINEERS,
Jan. 27. Secy., C. H. McLeod, Montreal, P. Q.
WESTERN SOCIETY OF ENGINEERS,
Feb. 1. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.
ENGINEERS' CLUB OF ST. LOUIS,
Feb. 1. Secy., Arthur Thacher, Odd Fellows' Building.
AMERICAN SOCIETY OF CIVIL ENGINEERS,
Feb. 1. Secy., F. Collingwood, 127 East 23d St., New York.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS,
Feb. 3. Secy., E. K. Smoot, 308 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST,
Feb. 3. Secy., O. Von Geldern, 710 Market St., San Francisco.
ENGINEERS' CLUB OF PHILADELPHIA,
Feb 4. 1122 Girard St. Secy., L. F. Rondinella.
NORTHWEST RAILROAD CLUB,
Feb. 4. Union Station, St. Paul.
MONTANA SOCIETY OF CIVIL ENGINEERS.
Feb. 4. Secy., F. D. Jones, Helena.
SWEDISH ENGINEERS' CLUB,
Feb. 4. Secy., P. Valentine, At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago. Secy., John Ericson.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL,
Feb. 6. Secy., C. L. Annan, City Engineer's Office.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
Feb. 7. Secy., Chas. S. Howe, Case School
ENGINEERS' SOCIETY OF PHŒNIXVILLE,
Feb. 7. Secy., W. Halliburton.

ENGINEERING NEWS

AND

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The date when the subscription expires is on the address label on each paper, the change of which to a subsequent date becomes a receipt for remittance. No other receipt is sent unless requested.

ADVERTISING RATES: 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

Practical experience with different systems of signal plant is making it increasingly clear that absolute safety in the operation of trains cannot be insured by either the manual system or the automatic system alone. The circumstances of a serious rear collision under the automatic system on the Central R. R. of New Jersey were recorded in our issue of Dec. 15, 1892, and in another column we give a letter from an experienced signal engineer in discussion of that accident. Two accidents within the past week, recorded in another column, under the manual system on the Pennsylvania R. R., as well as other previous accidents on that road, show that rear collisions may easily happen on lines operated by this system, through carelessness or mistake on the part of the operator. In all three cases a train which had stopped on the open track was run into by a following train, owing to disobedience to signals and rules on the part of the engineman in the case of the automatic system, and to the operators wrongly giving track clear signals in both cases of the manual system. In each of the two latter cases, the first train had been stopped, according to report, to allow of some slight repairs being made to the brake apparatus, and the operators did not wait to receive the telegraphic message indicating that the train had passed the next signal cabin. There is, of course, conflicting testimony from the operators, and no definite information as to their actions, or reasons therefor, can be given until after the official investigation. In the accident on the Jersey meadows the signal provided for purposes of safety to traffic was doubly a cause of disaster, as it not only by its position authorized the engineman to enter an occupied block section, but in looking at the signal the engineman failed to see the red lamp waved by a brakeman sent back from the train ahead.

The Pennsylvania R. R. is said to be planning an improved signal plant to insure greater safety than by the present system, but no definite information on this point has yet been given out. Safety in signal operations may be insured in two ways. First, by the adoption of the "lock and block" system, requiring the individual action of two or more men in the signal towers of different blocks to govern the movement of each signal. Second, by the adoption of some form of automatic arrangement (of which an example was described and illustrated in our issue of Jan. 12) by which the train sets the signal at danger, and the signalman cannot lower it to indicate safety until the train has passed off the block. A recommendation for the adoption of an arrangement of this kind is made in the Board of Trade report on the Thirsk collision on the Northeastern Ry., of England (Eng. News, Nov. 10, 1892), but Major Marindin, the inspector, refers only to mechanical appliances, and says that such appliances do not provide against a train breaking apart, so that it will still be necessary for signalmen to look out carefully for the tail lamps of trains, and for the conductor or brakeman of the rear section of a broken train to go back, in accordance with English rules. Electric appliances, however, as in the system described in our issue of Jan. 12, provide against this, as the signal cannot be lowered until every wheel of the train has cleared the block section.

The question of engineering ethics and the advisability of the adoption of a code of professional ethics is likely to come formally before the members of the American Society of Civil Engineers. As noted in the report of the business session of the annual meeting of the Society in our issue of Jan. 19, it was resolved by a vote of 52 to 8 of the members present to refer to the Board of Direction the matter of the appointment of a special committee on the subject. The duties of the committee would be to collect information in regard to the present codes of other professions, and to consider the propriety of the adoption by the Society of a code of ethics of the engineering profession. And, further, if the committee should decide that it is desirable and advisable that such a code should be adopted, it must prepare and report to the Society a draft of a suitable code for argument and discussion. Whether this committee shall be appointed lies, first, with the Board of Direction, and, second, with the membership, as the board must send out a letter ballot before proceeding with the appointment. Whatever the outcome may be, the present agitation shows that the question has been considered by a large number of members, and it is likely to be a very live issue.

At a meeting of the Cincinnati Association of members of the American Society of Civil Engineers held Jan. 6, the subject of a code of ethics for civil engineers was discussed, and it was the opinion of those present that a skeleton code at least, for the guidance of members of the profession, should be formulated and adopted. A considerable number of the members thereupon signed a memorial requesting that, if the proposition meets with the approval of the Board of Direction, the matter should be brought to the attention of the approaching annual meeting of the society. The memorial suggested that a special committee be appointed whose duties shall be: First to consider the propriety of the adoption by the society of such a code of ethics; and second, if the committee decides that it is desirable and advisable that a code should be adopted by the society, to proceed to prepare and report to the society at some future meeting such a code of professional ethics. The action had on this subject at the annual meeting of the Society of Civil Engineers was reported in our issue of Jan. 19. We cannot but feel that the time has come when some movement in this direction is called for, though any action had should be extremely cautious and tentative. In another part of this issue we give in full an address made before the Cincinnati Engineers' Club on the subject of "Engineering Ethics" by Mr. S. M. Whinery.

We devote considerable space in this issue to two papers on the dam across the Colorado River, at Austin, Tex., one prepared especially for our columns by Mr. E. W. Groves, the engineer in charge of the construction of the dam, and the other the official report of the Secretary of the Board of Public Works. Probably the most notable feature of the work of construction is the method which was adopted for handling the materials used in the construction of the dam, consisting of a cableway extending across the river over the site of the dam with the unprecedented span of 1,350 ft. We have, in previous issues, described in detail the cableway system of handling materials, but it seems well to call attention to the fact that it has now had sufficiently wide use to fully prove its economy and convenience on works of this sort. Besides the Austin dam, the Sodom dam on the Croton watershed was built by this method, and it is in use on the Butte City dam, described in our issue of Dec. 15. It has also been considerably used in constructing masonry arches.

A great advantage of the cableway system is that when the plant is put in place it need not be moved or altered until the work is done. The frequent changes of position required where an ordinary contractor's railway is used for moving material on such works increases largely the expense and time required. A criticism which might be made on the Austin plant is that many of the stones have to be handled twice, the cableway transferring them to derricks. This could have been avoided by the use of several parallel cables, the load being taken out on whichever one was nearest to the place where it was to be deposited. This has been done in handling masonry for bridge arches, and with satisfactory results, but the length of the cable was perhaps the objection at Austin.

A second advantage of the cableway is found in the fact that it is entirely clear of the work itself and is safe from injury by flood or fire, and reasonably safe from explosions on the work below. The importance of this has been fully shown at Austin. No less than eight different times during the past year has work on the dam been interrupted by high water, and at one time the water above the dam was 43½ ft. above low-water mark. Had the common plan of extending a railway out over the dam been adopted, these delays would have been greatly lengthened by the time necessary to replace the portions of track and trestlework washed away at these floods.

The cost of the Austin dam seems surprisingly small for a structure of such size and solidity, located at a long distance from markets and in a country where labor is scarce and high priced.

It is interesting to compare it in this respect with the Vyrnwy dam on the Liverpool water supply, described in our issue of Aug. 18, 1892. The following table gives the principal dimensions of each dam:

	Vyrnwy.	Austin.
Length, ft.	1,172	1,275
Height, ft.	161	68
Earth excavation, cu. yds.	220,820	105,618
Back filling " "	79,501	.....
Rock excavation, " "	.....	30,719
Masonry in dam, " "	260,000	95,000
Total cost	$2,840,000	$576,000

According to the above figures, which, so far as we know, are fairly comparable, the Vyrnwy dam is about two and two-thirds times as large as the one at Austin, and cost about five times as much. The character of the masonry in the two is not apparently very different. A great fuss was made over the "cyclopean rubble," with which the Vyrnwy dam was built, one-third the stones weighing over four tons each; but in the Austin dam limestone rubble blocks were placed measuring 5 cu. yds., and weighing about ten tons, and the largest single stones in the cut granite facing weighed nearly as much. Portland cement mortar was used in each dam, the cost of which was of course far more at Austin than at Vyrnwy. Perhaps the strongest contrast between the two, however, is in the time required for construction. The construction of the Vyrnwy dam occupied nearly eight years. The Austin dam contract was let in October, 1890, and, from present appearances, the dam will be completed in 2½ years from that date, notwithstanding the many serious delays due to the frequent floods in the Colorado River. There seems every reason to believe this creditable economy in both time and money to be largely due to American systems of handling men and materials.

We would particularly commend to our readers the letter of Mr. B. E. Fernow, Chief of the Forestry Division of the Department of Agriculture, contained in this issue. It is evident that the House Committee in charge of the appropriation required for a continuance of the government tim-

ber investigations and tests fails to realize the true importance of this work in its bearing upon a great industry and as a means of gathering and making public information of the highest importance to producers and users of building and other timber everywhere. It is not gratifying to realize that out of more than 50 varieties of useful timber, known and more or less used in the United States, our knowledge of their several qualities of durability and strength under varying conditions is practically confined to three, white and yellow pine and oak. And even this knowledge is based upon individual experiment, usually with inadequate apparatus. This subject of investigation is too broad for individual effort, and must cover all varieties of timber in all parts of the country, and be carried out on a scale of actual service application, to be really and fully useful.

As to the ultimate value of this government investigation, we have already the one piece of new information concerning the unimpaired qualities of Georgia pine that has been bled for turpentine. Until this subject was mechanically and chemically investigated by Mr. Fernow and his assistants this timber was ruled out of the market as valueless for building purposes. Its restoration to public confidence means a gain of at least a million dollars to the lumber industry of the South, says Mr. Fernow. Other timbers abundant in this country doubtless rest under a similar cloud of ignorance of their true qualities, and this cloud can only be removed by an equally careful and scientific study. Viewed from every point, this investigation into the qualities of our timber is one of the most important subjects lately taken up by the government, and the continuance of this work is a measure worthy of the most prompt recognition and encouragement by Congress, as we have already shown in former articles descriptive of this work.

If congressmen are so shortsighted as to fail to recognize, at this time, the importance of this work to their common constituents, then we agree with Mr. Fernow that it would be proper for public-spirited men to furnish funds for the next two years' experiments. As we have said before, this investigation is properly government work; but there is little doubt that with the apparatus now in hand, and with the experience already gained, the results of these two years' labor would be so marked as to materially assist Congress in realizing the true value to the country of this class of information, and make easier the appropriations necessary for fully completing the work. But we still trust that Congress will grant the means to further the eminently useful work of the Forestry Division. Engineers and builders are particularly interested in more fully knowing the qualities of the timbers they use, or can use; and every section of the country wants to know just to what extent local timber can be trusted and employed; and a liberal appropriation to these ends would be generally approved as a material benefit to the public interest.

The New Orleans "Times-Democrat" editorially recommends that the city should advertise for "a civil engineer of the highest ability" to carry out for the entire area of the populated part of the city the complete system of drainage which that journal thinks should necessarily follow the sewerage system now under construction. Why not advertise for a new city physician, a new judge of the court, or for any other professional man found necessary for the well-being of the city of New Orleans? Civil engineers of the "highest ability" are well known by their accomplished works, and can be easily found by the authorities of any city when the occasion demands. The leading journal of that section certainly does not mean to imply that the city authorities of New Orleans are incompetent to make a selection from among the engineers of the country "of the highest ability"; and if this is unhappily the case we cannot see how advertising will help them, unless they propose to measure this "ability" by the smallness of the fee charged for professional services. New Orleans has among its citizens some able civil engineers, and we would advise our contemporary to ascertain their views on this subject before repeating so absurd and unwise a suggestion.

RETAINING WALL THEORY AND PRACTICE.

The theory of retaining walls is one of a number of subjects (generally of more or less intricacy but no very great profundity) which seem to have a special and perennial interest for mathematically inclined engineers. Hardly a month goes by that we do not receive for publication some articles discussing the subject theoretically. We have no doubt that whoever may be editor of this journal a hundred years hence will have the same experience. We have received this week another discussion of the kind, the letter accompanying which we venture to reprint as a text for "a few remarks":

> Sir: I send you a manuscript on the theory of retaining walls. If this theory is correct, the engineer needs but the two factors of angle of slope and weight of material in order to ascertain at once the thrust in any given case. Both factors can be easily and quickly ascertained for each particular case in ordinary practice. Yours truly, N.

We must confess that we have not examined the manuscript critically. We judge its reasoning to be correct enough from its assumed premises, and it is certainly concisely put. But, supposing it to be absolutely correct, and an improvement on prior discussions of the kind, what of it? Not only under "this theory," but under any and all theories, if we know the "two factors of angle of slope and weight of material" we can ascertain at once the thrust in (not "any given case," as our correspondent carelessly puts it), but the given case. It is also true that by experiment or observation "both factors can be easily and quickly ascertained" after a fashion. What of that?

The essential difficulty about designing retaining walls which will stand up from such formulas is not the difficulty of ascertaining the static constants nor applying them by formula to the case in hand, but the two facts that: (1) these two alleged constants do not exhaust the list, and (2) neither one of the two "constants" considered can be relied on to remain constant, even from day to day, much less forever. Take the "angle of slope"; nothing is more indeterminate. At any given moment we can easily ascertain it, after a fashion, by using our eyes. Usually it is almost vertical, especially in clay, which will almost always stand vertical when excavated. In no reasonably dry material, except dry sand, will it ever be found so great as 1½ to 1. But how is it when that material is wet? Not only is its weight greatly increased, but the "angle of slope" will, or may, fall almost to the horizontal. That, in itself, might not matter, because in water it is already horizontal. But the pressure of water is independent of the volume confined, and dependent only in its vertical depth; but with ordinarily stable earth it is not so. When a slippery film forms under it somehow, so that its angle of slope is almost zero, it makes an immense difference whether the pressure comes from a small mass or from one extending outward and upward for a long distance. Approximately speaking, the pressure is about as great as if the wall were carried up as high as the highest point which is tending to move and filled in level behind.

When we further consider that the pressure is then approximately as great as if the wall were supporting a liquid twice as heavy as water, and if the slightest movement occurs may be many times more, it will be seen how utterly impossible it is to cover such contingencies by computation. In many soils, in most soils, they cannot occur; that is true; but who can say in advance whether the particular soil in question is one of those soils, or how much or little it may differ from it at some future time?

Then there is the great question of frost. This, when it gets a fair thrust, is absolutely resistless, and who can be certain in advance that he has avoided all risk of this? It is guarded against in part by suitable "weeper" holes at the foot of the wall, which, with the protection afforded by the thickness of the wall and a somewhat careful selection of the material for the backing, is usually sufficient. If the frosts are apt to be deep it is also necessary to give the back of the wall a sharp slope forward at the top, so that the expansion from frost may not give a dead thrust against the wall itself. But with all these precautions, which about exhausts the list, it is in not a few cases found impossible to protect against frost effectively.

For these reasons and some others, especially the uncertain quality of the stone or brick, mortar and foundations, no engineer in his senses ever undertakes to put up a retaining wall which he can guarantee against failure as he can guarantee a bridge truss under stated loads. He knows very well, if he knows what he is about, that there are great and uncontrollable forces which he cannot guard against completely which may come into play at any time, in spite of all precautions, to destroy his wall. What he does, therefore, if he acts intelligently, is to design a wall of such thickness as experience has shown will rarely fail,, and of such thickness that it is cheaper to take the risk of its failure than to pay out more material for insurance.

For this work theory affords no direct aid whatever. Good practice in this particular is based exclusively on the lessons of experience. It is well that every student should study the theory of retaining walls, and since it has become known from experience just what kind of a retaining wall will be likely to stand up, more or less successful efforts have been made to adapt theory to experience so that the two shall not seem to conflict. As a consequence, most of the theoretical discussions of modern text books no longer set forth as guides to the engineer formulas which give a wall sure to fall down in time, as did the formulas of 20 or 30 years ago, but the adjustment has been affected largely by modifying the constants recommended, and in so far as the formulas are even now acceptable and trustworthy, they are so from no merits of their own, but solely because they can be shown to agree with results of experience.

Partly because of these difficulties in rigorously analyzing the strains, but chiefly because retaining wall construction so long antedates retaining wall theory, there came into use long since a practical formula which we have once before expressed as "four-tenths of the height, and thrown in some odd inches for luck." It cannot be improved upon (unless by substituting three-sevenths for four-tenths, as is sometimes done). Volumes of hostile mathematics cannot shake it, nor volumes of friendly mathematics add to its just standing among engineers, because it is the accumulated result of centuries of experience. When the masonry is exceptionally good and well laid, the "odd inches" may be spared. When the masonry is exceptionally poor or the bank is of bad material, or is heavily surcharged, or the wall particularly important, the odd inches should expand into half the height in all. When two or more of these unfavorable conditions combine, the thickness should be more than half the height; and when the wall is of dry masonry and not very high the thickness should be made equal to the height at once, or nearly so, if failure is seriously objected to.

In these exceptional cases theory may be of advantage by aiding the judgment in selecting the percentage of increase, but, after all, not much. The two most essential facts to consider are: "What is it going to cost to replace the wall if it fails, and what will some given increase cost?" For example, suppose we are in doubt about the 6.4 + rule, and are considering an increase of thickness to half the height. The increased volume may be about $(50 - 42) \div 50 = 16\%$. Including the foundations, the increased volume may be 14%; the increased cost, which is for backing only, not more than 7%, if built by days' work or by a contractor who bids carefully. What will it cost to renew the wall if it fails? Generally at least as much as it cost in the first place, if the failure be general, all items considered. If failure be only local, it may be much less. If, then, it is feared that total failure may result in the one case, and only local failure, if any, in the second case, we have a simple economic problem before us: Can we afford to pay 7% for this particular bit of insurance? It is a matter of judgment which must depend on many circumstances, and every one must use the best judgment he has or can get hold of. He is foolish, indeed, to trust to anything else.

An occurrence within the editor's personal experience is a capital illustration of the truth of these remarks. An engineer, who was even then well known, had an important retaining wall to build. He was, and is, an expert mathematician; he also was then an experienced engineer. The wall was in his sole charge, and, like the famous

deacon, he "swore as deacons do, with an 'I du vum' and an 'I tell yeou'" he'd build a wall that should not come down, a veritable masterpiece! He studied and experimented and tested his materials with great zeal for some weeks. He neglected no precaution, not even that of "sitting on the wall most of the time during its construction." Never was retaining wall built with greater care—and within six months' time it was the worst looking wall one would care to see, a warped surface throughout, and most of it had to come down!

It may have been only a chance. It may have been only because he did not have the benefit of this latest discussion which our correspondent sends to us, and which we are withholding from an anxious profession without even studying it carefully; but we think differently. We think it was only because he trusted too much to his theories and experiments, and too little to the past results of accumulated experience. Our columns stand wide open to any one who will more fully tabulate and codify this experience; but unless and until we see a new light on the subject, there is no room in them for discussions of the theory of retaining walls.

The total immigration for 1892, in spite of the quarantine obstructions, fell off but little from 1891. But for those obstructions it would probably have exceeded it. By countries it was distributed as follows, the Canadian immigration of 40,000 to 50,000 or more per year not being included:

	1892.	1891.
Great Britain	56,745	64,834
Ireland	50,440	55,888
Germany	118,278	123,401
France	5,337	6,527
Scandinavia	55,274	52,262
Denmark	10,128	10,464
Dutch and Swiss	14,349	12,292
Total	310,551	325,670
Poland	26,880	31,285
Russia	52,267	73,177
Italy	60,257	68,481
Austria-Hungary	60,026	70,711
Total	200,339	243,654
All others	23,507	21,342
Grand total	543,487	590,666

Comparing December only, Russian and Polish immigration has almost entirely stopped, and Austro-Hungarian heavily decreased, but Italian immigration is much heavier than in December, 1891, and in all other cases there is little change. In the last 22 years, since 1870 inclusive, upward of 9,627,000 immigrants have arrived in this country, of whom perhaps 6,000,000 may be still alive and living in this country. The census of 1890 shows 9,249,547 foreign born residents (some 14.8% of the total population), of whom about 1,000,000 are natives of Canada.

The British Navy is rapidly gaining in strength. During 1892 the tonnage of vessels launched for its service was 141,200 tons. This compares with previous years as follows:

Year.	Vessels.	Tonnage.	I. HP.	Cost
1890	18	54,535	136,500	$12,530,140
1891	18	107,250	183,000	28,173,000
1892	22	141,200	191,500	39,030,000

Notwithstanding the great dockyards maintained by the government, over three-fourths of the expenditure of 1892 went to private builders of ships and engines. The vessels launched in 1892 include five first class battle-ships, each having a displacement of 14,150 tons and 13,000 I. HP., two cruisers of 10,500 tons and the same engine power, and five vessels of 7,350 to 7,500 tons and 12,000 I. HP.

Aluminum horseshoes, says "L'Avenir Militaire," have recently been tested in Russia. One hoof each of a certain number of horses in a regiment of dragoons was shod with an aluminum shoe, and the other hoofs with the ordinary iron shoe. It was found that the aluminum shoes had worn less, though they were only one-third the weight of the iron shoe. Their extra cost was considered as counterbalanced by the other advantages of the new metal. Though not so stated, some alloy of aluminum was probably used, as the pure metal would not show so good a record.

The new water-works of Havana, Cuba, were put in operation on Jan. 23, the birthday of the King of Spain, the Captain-General turning on the water. The cover to the reservoir has not been built, and meanwhile direct pressure will be used. Mr. E. Sherman Gould, M. Am. Soc. C. E., is Resident Consulting Engineer for the American contractors for the work, Runkle, Smith & Co.

LETTERS TO THE EDITOR.

AUTOMATIC SIGNALS AND THE GREENVILLE COLLISION.

Sir: I notice in your issue of Dec. 15, 1892, a brief account of a serious collision which occurred on the Central R. R. of New Jersey, at Greenville, in which 14 people were more or less injured, and at least one killed. While in the United States last autumn it was my pleasure to read a paper on "Railway Signaling" before the American Society of Civil Engineers (Eng. News, Oct. 27, 1892), and I also had the pleasure of meeting many railway managers and presidents. In all the interviews I had, and in the paper which I read, I unhesitatingly declared that automatic systems of signaling, whether electric or pneumatic, would be found to have such drawbacks, after experience, as not to commend themselves to managers and those responsible for the safe operation of railways.

In the accident in question, it appears that the two westbound express trains for High Bridge and Long Branch were running two minutes apart; the High Bridge express was stopped by the rear brakeman on the supposition that the train had struck a woman; the train stopped with the rear end of the last car 60 ft. within the block section, that is to say, under the protection of the stop signal applying to that section. Now, in the automatic pneumatic system, as applied on the Central R. R. of New Jersey and, I believe, as applied elsewhere in the United States, the train replaces, to the "danger" position, the stop signal immediately in its rear (in this case 60 ft. only), and

Plan of Trains and Signals, Greenville Collision; Central R. R. of New Jersey.

at the same time lowers the stop signal in the section in the rear, keeping the distant signal on that post at "danger." From the description, as far as I can gather, a sketch as inclosed gives you the signals, with the position of the train and the position of the signal arms.

It is well known, of course, as being one of the rules, that if a driver approaches a block signal with the distant signal at "danger" and the home signal down, that is, at "line clear," he is expected to be able to keep his train under control in order to stop at the next stop, or home signal, should it be against him. In this case, as per the diagram, the train upon passing C put signals 5 and 6 to the "danger" position, but at the same time set the home signal 4, at B (section in rear), to the "safety" position, the distant signal 3 meanwhile remaining at "danger." By all rules and with all authority, the engineman is absolutely authorized to pass B and proceed up to the stop signal 6; and under these conditions, with the express authority of all the officials on the line, he was only 60 ft. away from the train in advance. It is doubtful even whether 60 ft. is the minimum distance that can be authorized between two trains; I dare say if it were measured it would be found that 20 ft. in advance of signal 6 would place 6 at "danger," lower 4 to the "safety" attitude, and allow, as in this case, the Long Branch express to approach right up to signal 6, 20 ft. only from the train in advance, and, theoretically speaking, this system of automatic signaling, allows two trains to be only the distance of the thickness of a signal post apart.

I need hardly say anything further, with reference to this system of signaling, than that I had always understood that for safe working of automatic signaling two sections in the rear should be blocked, and not one only. As I expressedly pointed out in the paper above referred to, a distant signal is an anomaly, and it is not a stop signal in any sense of the word. Under either condition of the arm, "safety" or "danger," an engineman is absolutely authorized to pass it.

I should think this system will now receive the careful consideration of railway engineers, as this is only one of the defects of the system. Its adoption leads to one failing, which, I think, is a serious drawback, in addition to what I have pointed out, and that is that it tends to disobedience of orders on the part of enginemen, as they are more likely to disregard the signals than when they are under the eyes of the signalman, whose duty it would be to report such derelictions on the part of the enginemen.

I think in this case that the engineman is less to blame than the company, which prepares such traps for the enginemen as practically allowing authority for one train to approach another within the distance I have mentioned, theoretically the width of a post, practically 20 or 30 ft. Faithfully yours,

John P. O'Donnell,
Con. Engr., National Switch & Signal Co., Easton, Pa.
London, England, Jan. 13, 1892.

(Our correspondent is wrong in assuming any significance in the 60 ft. between signal and rear of train, which was merely the distance the train happened to run past before coming to a stop. In this system, as in others, an engineman is forbidden to pass a home signal at danger, but must stop in front of it, not knowing how far past it another train may be. The system in use on the Central R. R. of New Jersey was described in our issue of March 29, 1890, and this accident is referred to in our editorial columns.—Ed.)

UNITED STATES TIMBER EXAMINATION.

Sir: Allow me to thank you for the clear and concise statement in your issue of Jan. 12 regarding the present status of the United States timber examinations (I prefer this name to the less comprehensive one "timber tests.") As to conclusive results so far attained let me add that chemical analysis has confirmed the indications of mechanical tests to the effect that the timber of longleaf pine is in no way affected by bleeding for turpentine; the resinous contents of the heartwood remaining unaffected by the tapping, and hence even the durability is not impaired. This result is worth a million dollars at least to the lumber interests of the South.

As to the question of appropriations for this work I wish to say that the bill introduced at the last session of Congress (H. R. 5,758) calling for $40,000 to be devoted to this work—the sum is estimated on sound business basis—has not lost its status in this Congress, but remains where it was left at the last session, namely, pigeon-holed in the Committee on Manufactures, Hon. Chas. H. Page, of Rhode Island, Chairman, and Hon. M. D. Harter, of Ohio, Chairman of Sub-Committee, to which the bill was referred. All those who think that this expenditure of public money is desirable, that the people at large are benefited by it, that such knowledge as is thereby attained is "the foundation of all material and permanent progress in the arts and sciences," should write directly to the two gentlemen named as well as other delegates, especially members of the Committee on Appropriations, and press their views regarding the matter upon them.

On the other hand, I am advised that it is useless to ask for any increase of appropriations at the present time; least of all for such a poorly supported bureau as the Forestry Division. It is, therefore, not likely that this interest will be provided for in such a manner as to put it on a desirable practical basis either by the present or the next Congress.

I would, therefore, suggest that those private interests, like the engineering profession, the railway and bridge builders, the wood-working industries and the lumbermen, all of whom are most directly and pecuniarily concerned in the results of this work, could show their interest by providing the funds to carry it on.

I am convinced that if the matter were properly presented to these interests and a practical plan of collecting and using the funds devised, that there would be found a sufficiently large number of broad-minded business men in these professions and industries, who would contribute their share toward such work.

I would suggest that this is a matter in which Engineering News, engineering societies and other similar agencies could make themselves highly useful. A fund of $50,000 in connection with funds appropriated by the government and the facilities at the command of the government would within two years of continuous application remove at least the gross ignorance existing regarding even our most common timbers. There would not then be any question as to the true value of Douglas Spruce or Bald Cypress; there would not be a difference of opinion based on slender facts, whether creosoting is or is not detrimental to strength; whether this or that method of seasoning is preferable; there would not be necessary a struggle every time a new material tries to get recognition in the market and with the engineering profession.

With such a fund, it would be proper policy to cater quickly to some of these pressing needs of practical engineering first, leaving the more elaborate and scientific work laid out by the plans for the Forestry Division to be followed up later and perhaps at a more moderate pace.

If this appeal find a responsive chord I shall be most willing to elaborate such a plan of co-operation. Who will be the champion to break a lance for this eminently useful and practical work? B. E. Fernow,

Chief of Forestry Division, Dept. of Agriculture.
Washington, D. C., Jan. 18, 1893.

THE HEIGHT OF THE NEW EAST RIVER BRIDGES.

Sir: In his recent decision on the plans for the proposed bridges across the East River the Secretary of War has placed their least height above the water at their centers at 140 ft., or 5 ft. higher than the present New York & Brooklyn Bridge. The plans submitted provided for a height of 135 ft., the same as that of the present bridge, which was deemed sufficient inas-

much as no vessel carrying spars of greater height could pass the present bridge, and any decrease in the height of the bridge correspondingly decreased the expense of terminals. The report of the Government Engineer Corps, however, recommended that the height be increased to 145 ft., and the Secretary of War has compromised by "splitting the difference." In view of the fact that the present bridge limits the size of the vessels entering the East River from the south and that the number of vessels with spars requiring more than 135 ft. for clearance coming to an anchorage between the two bridges by the way of Long Island Sound is exceedingly small, the reasons for the extra height of 5 ft. do not seem clear. As the decision was rendered "after careful consideration," however, these undoubtedly exist, in the minds of the government officials at least. Perhaps you may be able to explain them. Very truly yours, X.

New York, Jan. 21, 1893.

(Like our correspondent, we are unable to see any reason of much weight for increasing the height of these bridges above that of the New York and Brooklyn bridge, viz., 135 ft. at the center and 120 ft. at the abutments. If there are such reasons, it would be of interest to have them made public.—Ed.)

LAYING SUBMERGED WATER MAIN ACROSS THE SUSQUEHANNA RIVER AT MONTOURSVILLE, PA., J. P. Herdic, Contractor.

LAYING SUBMERGED PIPE ACROSS THE SUSQUEHANNA RIVER AT MONTOURSVILLE, PA.

Sir: I send you a photograph of my crew of pipe-layers, taken near the north shore, as we were about laying the last length of pipe with ball joints across the Susquehanna River, near Montoursville, Pa. The photograph (reproduced herewith) shows the 10-in. pipe with a ball joint on the lower end of the last pipe calked. The pipe was supported by means of a strong trestle, with legs resting on either boat, over the pipe. Chain pulleys are used for raising or lowering the pipe into the water, they being attached to the center of the trestle directly over the pipe. I used in laying 600 ft. of pipe across water which averaged 13 ft. in depth, six regular cast iron joints to one ball joint and covered the spaces, including making preparations, in 3½ days. The first day was taken up in stringing ⅞-in. manilla rope, loading boats and adjusting the lines from the ferry line to the boats. The submerged pipe was laid on a gradual curve across the river, with the bend up stream to act as a brace against strong currents.

I consider this the quickest and best way to lay pipe across water, and much less expensive than by any other system known to me.

James P. Herdic, Engineer and Builder.

Williamsport, Pa., Jan. 15, 1892.

CRUSHING STRENGTH OF GRANITE.

Sir: Referring to your editorial note in your issue of Jan. 12, on the crushing strength of granite, permit me to say that I have in my possession two test specimens of a slate colored granite from the quarries located at Berlin, Wis., each measuring exactly 2×2×4 ins., which have stood a crushing strain of 100,000 lbs. without spawling or crushing; in fact, they left the testing machines as clean and untouched as they went in. The above pressure comprises the full capacity of the testing machine, which I have ever since regretted, as it would undoubtedly have been very interesting to know what these specimens would have done. They were thus tested in 1888, and again in 1890 with the same result. Respectfully, W. Otto Groum, M. E.

Rock Island Arsenal, Rock Island, Ill., Jan. 19, 1893.

THE AUSTIN DAM.

By E. W. Groves, Engineer in Charge of Construction.

The surveys for this work were started in May, 1890, the contract was awarded the following October, and the work of excavation was immediately commenced.

The design adopted called for a dam 60 ft. above low water level, having both upstream and downstream faces constructed of granite; the interior to be constructed of limestone of good quality, weighing not less than 150 lbs. per cu. ft., all to be laid in Portland cement mortar made of 1 part cement to 3 of sand. The limestone is obtained in the immediate vicinity of the work, while the granite is brought by rail 60 miles.

During the winter, while the excavation was being made, and the railroad being extended from the city to the site of the dam (three miles), the contractor was busy assembling his plant for handling the vast quantity of material to be used in the construction of the dam.

Perhaps the most notable piece of machinery employed on the work is the overhead cableway, designed and furnished by the Ligerwood Manufacturing Co., of New York, which, owing to its efficient work, demands more than passing notice. From the natural conformation of the ground, this was an ideal place for the location of this piece of machinery. The west bluff rises nearly vertical to a height of 65 ft. above the crest of the dam, while the east bluff rises 10 ft. above the dam. This cable is suspended on two towers; the easterly one, in which is situated the hoisting engine, being 70 ft. high, and the westerly one 30 ft. high. The main cable on which the carriage moves is 2½ ins. in diameter, 1,850 ft. long and 1,350 ft. between points of support.

This is the greatest span of any hoisting cableway in exeistence.

On the west side of the river, and 1,200 ft. up stream from the dam, is situated a limestone quarry, from which extended a gravity railroad along the west bluff directly under the cable. A carload of rock could be run from the quarry to the cable, taken up at once and transported to derricks on any portion of the work. A double track was used near the dam so that an empty car was ready to receive the empty skip, and a loaded car was also ready when the carriage came for a load. This gravity road was submerged as soon as the dam was raised 5 ft. above low water, and recourse is now had to barges, carrying 20 cu. yds. of rock, which is brought to the side of the dam and there unloaded with a steam derrick. Under the cable at the easterly end of the dam extends the railroad bringing granite from the quarries, which can be taken from the cars and transported to any portion of the work, in the same manner as the limestone. Mortar is mixed on the wall near the workmen, sand and cement being taken out by the cable. Loads of about five tons are usually carried. This cable is capable of supplying about 180 cu. yds. of material per day where the distance to be traveled is not more than 1,000 ft.

During the laying of the foundation, considerable water was encountered, the excavation in places being carried 11 ft. below low water in the river to get to solid rock. Two 6-in. discharge centrifugal pumps were used to keep the foundation dry, but in places where it was impossible to get the bottom of the trench in good condition to bed stones properly, concrete was used to lead up above the water.

Strong flowing springs were encountered in various parts of the foundation, which gave considerable trouble until wrought-iron pipe was made use of. The water from the springs was conducted to the pumps through pipes of suitable size, the pipes being covered with masonry and the spring surrounded by a wall of masonry, well built. After the mortar had thoroughly set this well would be filled with rich concrete, and no more trouble would be experienced from that spring. The end of the pipe was stopped with a plug or iron cap.

A gap was left in the dam, about 500 ft. from the east end, 50 ft. wide and 45 ft. above low water level, and through this the river was turned by means of a cofferdam constructed of limestone and earth. When this was accomplished, masonry was laid in the channel of the river.

FIG. 1. THE WATER POWER DAM AT AUSTIN, TEX., ON THE COLORADO RIVER.

Near the west bluff three 36-in. cast-iron pipes have been placed 13.5 ft. above low water, with valves set in the dam 12 ft. from the up-stream face. A chamber 4×6×15 ft., with manhole to the top of the dam, gives access to these valves.

The pipes not having sufficient capacity to carry the entire flow of the river, gaps were left in the dam, with a difference in elevation of about 12 ft., and these are closed with heavy timber gates, supported on a sill of granite at the bottom which projects about 24 ins. from the face of the wall, and resting against upright posts fitted to the face of the dam. The following table gives the figures of principal interest concerning the dam and the water power:

Length of spillway	1,125 ft.
Length of dam, including bulkhead	1,275 "
Height above low water	40 "
Maximum height above foundation	68 "
Width of base	66 "
Power available (for 60 hours per week)	14,500 HP.
Minimum flow	1,000 cu. ft. per sec.
Maximum flow	250,000 cu. ft. per sec.
Drainage area, above dam	50,000 sq. miles.
Length of lake formed	25 miles
Area of lake formed	2,000 acres
Masonry in dam	95,000 cu. yds.
Maximum size of rubble used	5 cu. yds.
Maximum size of granite used	93.5 cu. ft.

Approximate cost of entire plant, including dam, power house, reservoir and distribution system, $1,400,000.

Power House.—A granite faced revetment wall on the easterly bluff will form a retaining wall for a distance of 260 ft. down stream from the toe of the dam, and will form the foundation of the west wall of the power house. The east wall will rest on the ledge of the cliff, 44 ft. above low water. At the easterly end of the dam water will be taken from the lake through eight 9-ft. penstocks and conducted to the turbines.

There are to be four pairs of horizontal turbines of 506 HP. each, under 54 ft. head. Each pair of these turbines will discharge into a common draft tube. On each turbine shaft there will be two pulleys, from which belts will be led to the dynamos.

There will also be two vertical turbines, each of 200 HP., under 54 ft. head, each shaft to be connected with a pump by means of bevel gear.

There are to be two pairs of horizontal, double-acting pumps, of the plunger type, having two pump cylinders to each pair, each pair of pumps to have a capacity to deliver 4,000,000 gallons per 24 hours.

Reservoir.—On the west side of the river, one and one-quarter miles from the dam and four miles from the city, will be built a reservoir of about 100,000,000 gallons capacity. This will be made by building a dam of earth and rock, with masonry heart wall across the ravine, the supply pipe, 24 ins. in diameter, being carried across the river on corbels projecting from the face of the dam, shown in Fig. 1.

The pipe distribution system for the city waterworks will comprise about 40 miles, the pipe varying in size from 24 ins. to 6 ins. in diameter.

THE REPORT OF THE AUSTIN BOARD OF PUBLIC WORKS.

We reprint below the official report of the Secretary of the Board of Public Works of Austin, Tex., which, in connection with the paper prepared for this journal by Mr. E. W. Groves, the engineer in charge of construction of the great dam, gives a very good account of the engineering features of the enterprise in which the city of Austin is now engaged. For previous descriptions of this work, and of the controversy to which it has given rise, see our issues of July 11 and Nov. 14, 1891; April 9, Aug. 18, Sept. 29, Nov. 10, and Dec. 22, 1892, and Jan. 12, 1893.

We print the report practically in full, omitting only those portions which are only of local or trivial importance:

To Hon. John McDonald, Mayor of Austin:

Sir: I have the honor to submit the following report of operations under the direction of the Board of Public Works during the year ending Nov. 30, 1892:

Early in the year a serious difference of opinion concerning the best method of utilizing the water power created by the dam and the proper location of the power house arose between some of the members of the board and Mr. J. P. Frizell, the chief engineer. The plans prepared by Mr. Frizell provided for a hydraulic canal extending from the east end of the dam and for the location of the power house on the bank of the river some 600 ft. below the dam and about one-half that distance from the canal, and for iron penstocks leading from the canal to the power house for conveying the water to the turbine wheels.

Some of the members of the board were of the opinion that the power could be better utilized by conveying the water directly from the lake to the wheels through iron penstocks, and that it would be safer to locate the power house on the rock ledge below the dam, where it could not be damaged by high water.

In January Mr. E. Geyelin, a hydraulic engineer of Philadelphia, Pa., was requested by the board to give his professional opinion in the matter. Mr. Geyelin visited Austin in February, and after examining all the plans and the location of the works for several days, reported in favor of locating the power house on the solid rock about 100 ft. below the east end of the dam, and the use of iron tubes or penstocks for conveying the water from the lake above the dam directly to the wheels, instead of having a canal as proposed by Mr. Frizell. He also recommended that the water main leading to the reservoir be laid upon headers projecting from the upstream face of the dam about 5½ ft. from its top.

Mr. Geyelin's report was adopted by the board, but it was subsequently attacked by Mr. Frizell in another report on the same subject, Mr. Frizell strongly adhering to his original plan of having the water pass through a canal and locating the power house on the alluvial soil on the bank of the river. He also recommended that the water main to the reservoir be laid in the bed of the river below the dam.

This great difference of opinion between two engineers rendered it impossible for the board to arrive at a conclusion which plan was correct without further advice on the subject, and desiring to avoid any mistake in such an important matter, secured the services of Mr. J. T. Fanning, of Minneapolis, Minn., one of the most celebrated hydraulic engineers in America.

Mr. Fanning spent the whole of the month of June in Austin carefully examining everything connected with the great work on hand, and on June 24, in an elaborate report (see Eng. News, Aug. 18, 1892), he sustained Mr. Geyelin's views in the main points but recommended the location of the power house on the solid rock close to the east end of the dam instead of 100 ft. below, also the use of iron tubes or penstocks for conveying the water directly to the wheels instead of using the canal and locating the power house as insisted upon by Mr. Frizell. Mr. Fanning also approved of the plan of carrying the water main to the reservoir on headers projecting from the face of the dam, as recommended by Mr. Geyelin.

Another question, which had previously arisen between the board and Chief Engineer Frizell, was what should be the proper form of the down stream part of the top of the dam. The working plan showed the top of the dam to be flat, and some fears were expressed that the foundation would be endangered by the falling of heavy masses of water beyond the toe of the dam during great floods in the river. This question was also referred to Mr. Fanning, and in his report he recommended that the form of the crest of the dam be changed so as to have a curve of 20 ft. radius, as being better adapted to pass the flood in a gliding sheet down the face of the dam and to deliver it to the lower level without a direct blow.

Mr. Fanning's report was accompanied by drawings and sketches illustrating his recommendations, and it was adopted by the unanimous vote of the board, which action was subsequently ratified by the city council.

Mr. Fanning was then retained as consulting engineer and requested to complete the plans for the works recommended in his report.

Mr. Frizell tendered his resignation as chief engineer to take effect on June 30, 1892, and the same was accepted by the board.

The board assigned Mr. E. W. Groves to duty as engineer in charge of the construction of the dam and Mr. N. Werenskiold as engineer in charge of the water distribution system, construction of reservoir, etc.

The Water Distribution System.—Mr. Fanning at the request of the board, after careful surveys, also prepared a plan for the water distribution system embracing the entire city. It provides for a settling basin or reservoir with a storage capacity of 100,000,000 gallons, two pairs of 4,000,000-gallon pumps, 42 miles of cast iron pipes ranging in size from 6 ins. to 24 ins. in diameter, and 169 valves, and 230 of the best quality and latest improved double-nozzle fire hydrants with double independent cut-offs, etc.

The connection with the pumping station is such that the water supply can be pumped directly from the river or drawn from the reservoir as may be desired.

The plans prepared by Mr. Fanning were adopted by the board and they provide for two water mains to the center of the city, a 24-in. main leading straight across from the dam to Magnolia avenue, and one 16-in. main leading down the boulevard and Pecan street to Congress avenue, and the two connected by a 20-in. main. Smaller pipes will connect all parts of the city, and there will be no dead ends.

The selection of a site for a reservoir was attended with considerable difficulty, both on account of the nature of the ground in the vicinity of the dam and of the many hills within the city limits.

Surveys were made in every direction and every point was carefully examined. The place finally selected as the most suitable site for the reservoir is at the little Bee Creek on the west side of the river, on property owned by Maj. J. T. Brackenridge, about 6,000 ft. from the dam. The contour of the ground at this place is such that by building an earthen dam about 500 ft. long and 40 ft. high at the deepest place across the mouth of a small canyon, a reservoir with a storage capacity of 100,000,000 gallons can be obtained at an estimated cost of $60,000. The reservoir will be 300 ft. above the low water level of the river and 115 ft. higher than the base line of the State Lunatic Asylum building, the highest point in the city. In the immediate vicinity of this site are two other places which can be converted into settling basins or reservoirs of

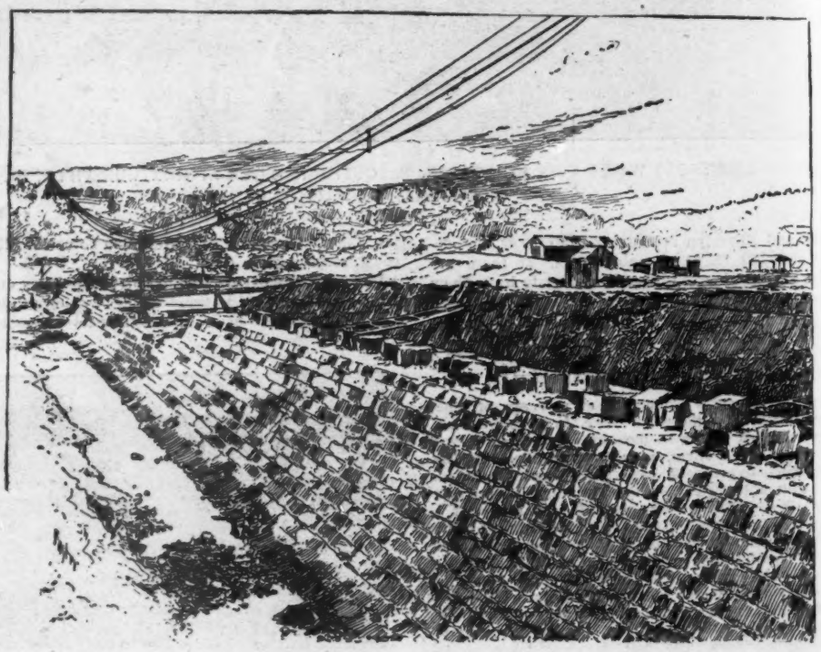

FIG. 2. CABLEWAY USED IN CONSTRUCTION OF AUSTIN DAM, 1,350 FT. SPAN.

50,000,000 gallons capacity each, at a comparatively small cost, whenever the city requires additional reservoirs.

The place decided upon has received the approval of all the engineers engaged on the work, and Mr. Fanning strongly recommended its selection. At the request of the board a committee of prominent physicians and sanitary engineers visited the different locations proposed, and they reported favorably on the site selected, from a sanitary standpoint.

Contracts.—During the year ending Nov. 30, 1892, after due notice by extensive advertisement, contracts were awarded by the Board of Public Works and ratified by the City Council as follows:

160 valves, Rensselaer Mfg. Co., Troy, N. Y...	$3,700.15
230 fire hydrants, R. D. Wood & Co., Philadelphia	5,798.50
Laying 42 miles, pipe, all sizes, Wingfield Bros., Chattanooga	59,743.00
Headgate masonries and excavation for power house foundations and wheel pits, James Waterston, Austin; estimated at	47,000.00
Headgate castings, penstocks and other iron work, Riter & Conley, Pittsburg	57,550.00
Turbine wheels to develop 2,400 HP. and two pairs of 4,000,000-gallon pumps, Stillwell & Bierce Mfg. Co. and Smith & Vaile Co., Dayton, O. (combined bid)	37,580.00
Iron beams, etc., for power house, Stillwell & Bierce Mfg. Co., Dayton, O	10,374.68

on the west side was made in the latter part of May. During the month of September three 36-in. cast iron sluice pipes with heavy geared valves were inserted in the dam near the west end at an elevation of 13½ ft. above low water. The board decided to have these sluice pipes laid in the dam in order to avoid any difficulties which might arise from the stoppage at any time of the entire flow of the river, and also to enable the contractor to more easily control the water when closing the gap in the dam, the contractor agreeing to pay one-third of the cost of the same. The cost of said sluice pipes and valves in place was $2,287.31.

A small gap, 15 ft. wide and 13½ ft. above low water, was left in the masonry 55 ft. from the west end of the dam, and on Nov. 22 a wooden coffer-dam was placed in front of the large gap and the water was raised so as to pass through the small gap and the sluice pipes near the west end of the dam.

The amount of work done on the dam during the year was as follows:

	cu. yds.
Earth excavation	2,737
Rock excavation	899
Granite masonry laid	10,851
Limestone rubble masonry laid	40,322
Concrete masonry laid	156

also by the decision to have the entire dam laid with Portland cement, which, under the contract, cost 50 cts. per cu. yd. extra.

Head Gate Masonries and Excavations.—Mr. James Waterston executed his contract for the Head Gate masonries and excavations for the power house foundations and wheel pits on Sept. 2, and on Sept. 20 commenced the work of excavating. He was at first delayed in his work on account of difficulty in securing men and teams, also by bad weather and high water. At the close of the year he had excavated as follows:

	Cu. yds.
Earth excavation	24,535
Rock excavation	2,620

The amount paid to Mr. Waterston under his contract to Nov. 30, 1892, was $4,783.50.

The Railroad.—The amount paid out during the year on account of the railroad to the dam was $5,070.34, divided as follows.

For work done and materials furnished by the Houston & Texas Central R. R. Co. in making connection with said road	$368.33
For telegrams	2.85
For masonry and iron bridge at the crossing of the International & Great Northern R. R.	4,698.96

When the railroad was being built the Board of Public Works agreed with the International & Great North-

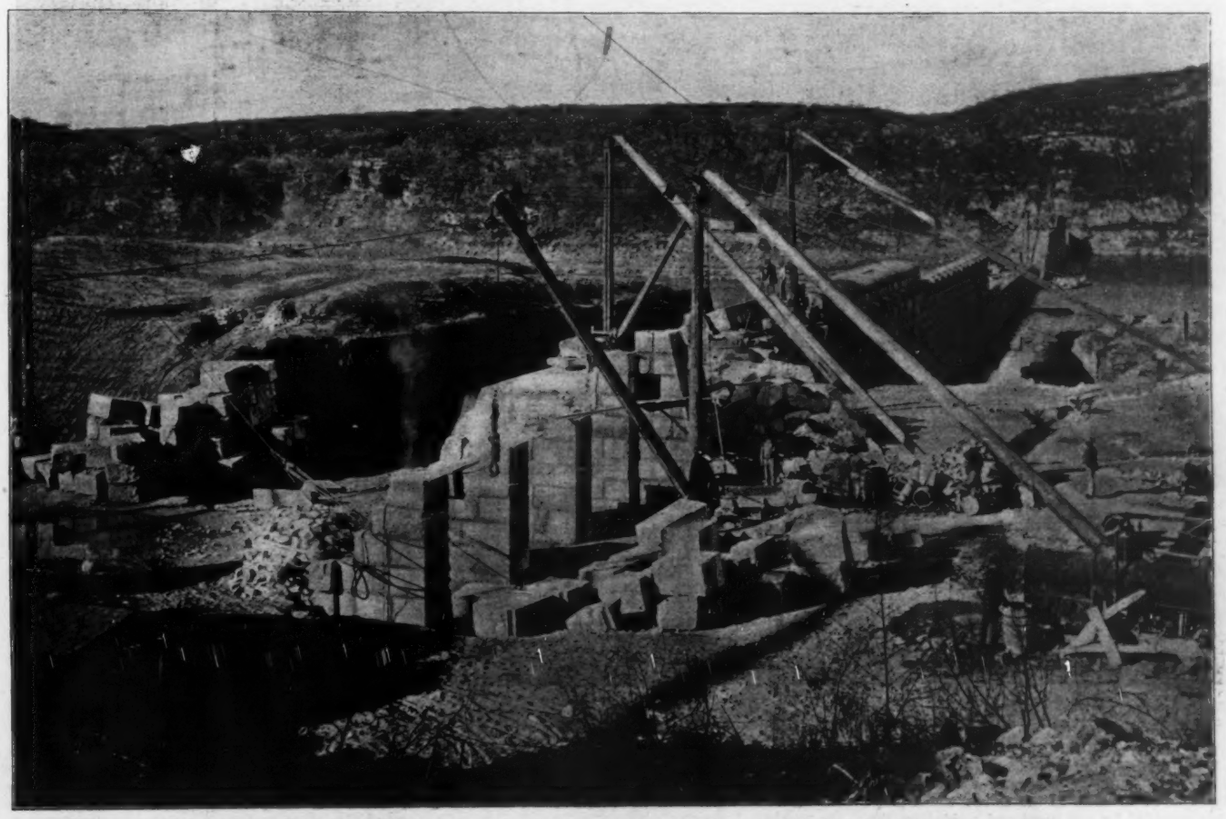

FIG. 3 HEAD GATE MASONRY IN PROCESS OF CONSTRUCTION AT EAST END OF DAM; JAN. 4, 1893.

No contract has yet been made for water pipe. A number of bids to supply pipe and special castings were received on June 22, but none of them were deemed by the board to be satisfactory and they were all rejected. The board is now preparing to let the contract for all the water pipe required by the plans at an early date.

The Dam.—Work on the dam was interrupted a number of times during the year by bad weather and high water, there having been no less than eight different rises of sufficient depth to cause a suspension of the work, sometimes for as long a period as three weeks. The last large rise came suddenly on Oct. 22, and raised the water above the dam 43½ ft. above low-water mark.

The work was further delayed on account of the difficulties met with in turning the current of the water through the large gap that had been left in the masonry 685 ft. from the east end of the dam. The contractor built a coffer dam of rock and earth connecting with the west bank of the river, but it was damaged or partially washed away by rises in the river no less than four different times. While rebuilding it the last time a smaller coffer dam was placed in the bed of the river near the west bank and the masonry at that point was commenced. Masonry connection with the rock bluff

Making the total amount of work done by Mr. Corrigan to and including Nov. 30, 1892, to be as follows:

	cu. yds.
Earth excavation	105,618
Rock excavation	30,719
Granite masonry laid	14,840
Limestone rubble masonry laid	59,513
Concrete masonry laid	343

The elevations of the dam above the low water mark of the river at the close of the year were as follows: For a distance of 375 ft. from the east end of the dam 54½ ft. for a further distance of 280 ft. to the large gap, 38 ft., from the large gap to the small gap, a distance of 325 ft., the average height was 48 ft., and from the small gap to the west end of the dam, a distance of 55 ft., the height was 40 ft.

The amount paid to Mr. Corrigan during the year for work done and materials furnished was $246,689.92 and the total amount paid him under his contract on Nov. 30, 1892, was $396,657.25.

The last estimate made by Engineer Frizell of the total cost of the dam when completed was $575,940. This increase in the estimated cost of the dam over the original estimate was caused by the increased depth of the excavation at the east end of the dam, and the consequent increase in the amount of masonry required.

ern R. R. Co. to have said company build a permanent iron bridge over the gap where the city's railroad passed under the International & Great Northern R. R., in place of the temporary wooden structure at first erected, the price agreed upon being $3,500 for the ironwork and all necessary masonry at cost.

The bridge was built according to agreement; and the bill rendered, itemized, was as follows:

Masonry in place	$1,198.96
Ironwork in place	3,500.00
Total	$4,698.96

The railroad was delivered to the company that had leased it in December last, and it has since been operated as a passenger line to the satisfaction of the public and without interference with the right of way for the materials used in the construction of the dam and other works. The rental, amounting to $5,000 per annum, has been promptly paid into the city treasury and pays the interest on $100,000 of the water-works and electric light bonds.

Finances.—Bills and accounts were approved by the Board of Public Works and ordered paid during the year ending Nov. 30, 1892, as follows.

Bernard Corrigan, under his contract	$246,689.92
Bernard Corrigan, balance on cement	378.50
James Waterston, under his contract	4,783.80
Railroad	5,070.34
Salaries of engineers, inspectors, etc.	13,405.18
Engineering expenses, including fees of consulting engineers	5,977.34
Maintenance of horses and wagon	310.38
Fireproof safe and moving same	157.50
Salary of right-of-way agent	458.34
Damages to lands above the dam	2,162.00
Clearing lands	2,096.12
Sluice pipes in the dam	2,287.31
Office expenses, including postage, rent, etc.	107.50
Miscellaneous expenses, including fuel, ice, exchange, labor, etc.	499.22
Total	$284,975.46

which, added to the $259,862.07 paid out to Nov. 30, 1891, makes the total amount paid out to and including Nov. 30, 1892, $544,837.53.

On April 8, 1892, a proposition was submitted to the board by the United States Trust Co., of Kansas City, Mo., and Col. Geo. W. Brackenridge, of San Antonio, Tex., to purchase $500,000 of the water-works and electric light bonds at 95 cents on the dollar, which proposition was accepted by the board and ratified by the City Council. The bonds were at once delivered and the money, amounting to $475,000, paid into the city treasury.

The secretary's books show the water and light fund on Nov. 30 to be as follows:

400 bonds sold in 1890	$400,000.00
500 bonds sold in 1892	475,000.00
Balance of appropriation refunded	45.00
Proceeds of sale of horses	160.00
Total to Nov. 30, 1892	$875,205.00
Total paid out to Nov. 30, 1892	544,837.53
Balance on hand	$330,367.47

Electric Lighting Plant.—In his report rendered in June, Engineer Fanning outlined a complete system of electric lighting by incandescent lamps and for electric power, and he was requested to furnish plans and estimates providing for converting the power of three 500 HP. water wheels into light and one 500 HP. wheel into power. The plans, etc., are about completed.

Plans and specifications for the reservoir, also for the power house, have been completed.

The question as to whether the lake created by the dam would fill up with sediment was thoroughly canvassed by the board, and the professional opinion of a number of engineers on the subject was obtained. The engineers were all of the opinion that the rush of water during high floods in the river would carry the silt over the dam, and that the lake would never fill up so as to interfere with navigation, or to any appreciable extent.

On Aug. 15 Judge Haecock resigned from the board on account of continued ill health. This reduced the Board of Public Works to the minimum number allowed by the ordinance, and it now consists of John McDonald, President; Dr. M. A. Taylor, Vice-President; Frank Hamilton, A. P. Wooldridge, W. C. Walsh, S. K. Morley and John W. Maddox. The employees of the board at the close of the year were: one secretary, two engineers, one assistant engineer, three inspectors of masonry and one right of way agent.

The contracts yet to be awarded are for the erection of the power house (for which advertisement has been made), for the construction of the reservoir, for dynamos, for wiring the city and for water pipe, all of which the board is now preparing to let.

The board is satisfied that the entire system as originally contemplated will be completed during the coming summer, and within the appropriation voted by the people. Respectfully submitted,

W. J. Oliphant,
Secretary, Board of Public Works.

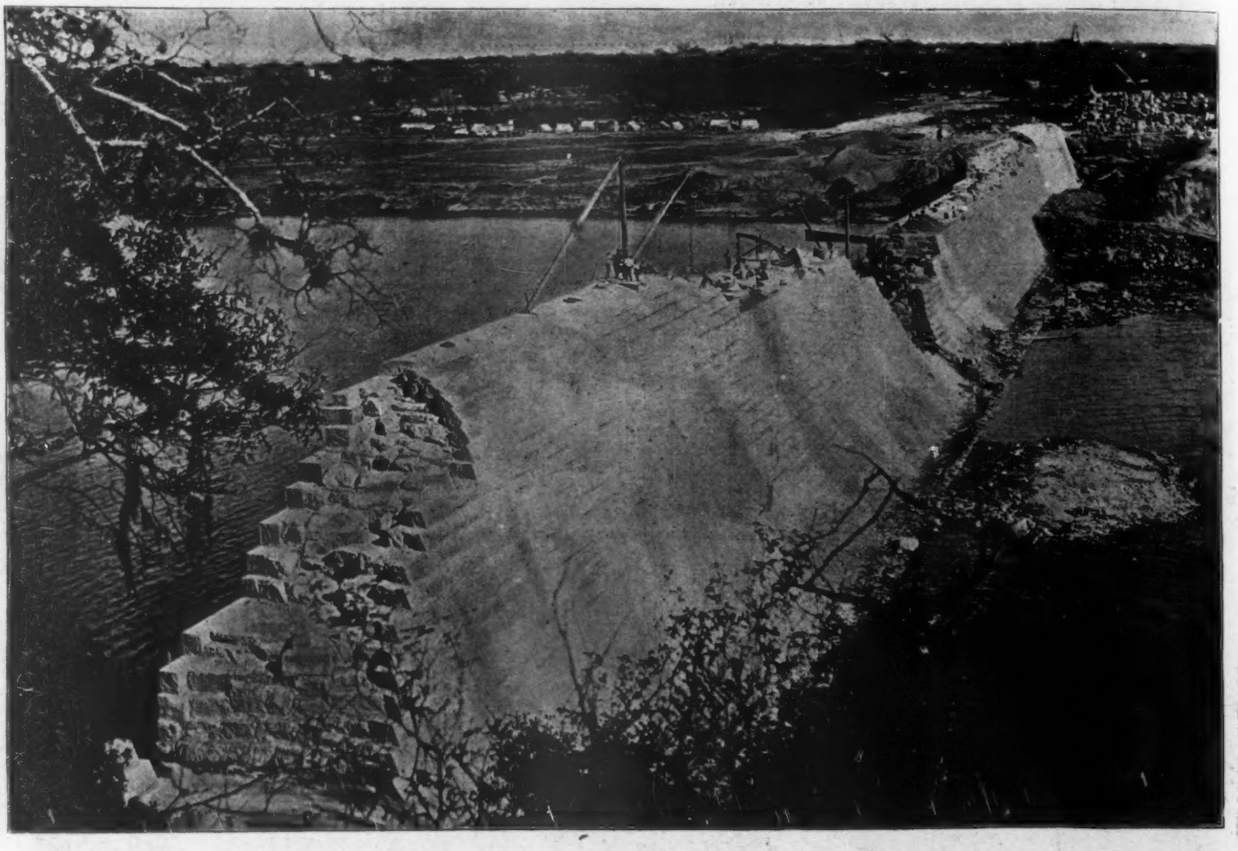

FIG. 4. VIEW NEAR WEST END, SHOWING PORTION OF COMPLETED DAM; JAN. 4, 1893.

THE ENGINEERING SCHOOLS OF THE UNITED STATES.

XXXIX.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY.—LENGTH OF COURSE.

Sir: I have received your letter of the 13th inst., in which you call attention to certain unfavorable comments in Engineering News of Jan. 12 upon the shortness of the school year at this institution, and express your willingness to print whatever the Massachusetts Institute of Technology may desire to have said in reply. Please accept my thanks for your courtesy.

1. As to the facts of the case: The article in question states that there is a difference of a week in our school year as between the civil engineering and the mechanical engineering departments—the former having 34 and the latter only 33 weeks of term time. It is also stated that, in order to reach this total of 34 weeks for the civil engineers, it has been necessary to add in four weeks of vacation work. Both these statements are erroneous. The length of the year is precisely the same for both civil and mechanical engineers. Nor is it necessary to count any of the summer school time in order to make up the full 34 weeks. All the summer school time, whether in civil or mining engineering, or in geology, constitutes a pure addition to the school year.

The school year of the Massachusetts Institute of Technology is divided into two terms of equal length. Each of these comprises 15 weeks of advance work, followed by 2 weeks of examination, during which the student, in probably nineteen cases out of twenty, makes a rapid review of each subject of examination. Of course, if the student has not mastered the subject during the 15 weeks preceding, such a rapid review becomes a mere cram, useless, and perhaps injurious. If the student has mastered the subject during his advance work, such a rapid review becomes one of the most helpful and healthful of intellectual exercises, giving him an outlook over the field which, if he is a good student, he will never lose. I think it is hardly necessary to add that at the Massachusetts Institute of Technology the students do, as a rule, master their subjects during the period of advance work; and, consequently, these reviews constitute an important part of the 17 weeks of work making up each term.

2. As to the reason of the case: Whether college vacations should be long or short is a question which certainly has two sides; but I do not believe that the scale has generally been turned in this country in favor of long vacations by the desire of college professors to disport themselves at the seaside or among the mountains. It is not impossible that the question should be differently decided by different institutions, and yet both be right, reference being had to their several kinds of work, discipline, location (as between a hot and a cold district), and other considerations. I will not attempt to speak for other institutions, but merely for the Massachusetts Institute of Technology; nor even for this school would I presume to say that the course which has thus far been maintained may not, for reasons, be departed from in the future.

In the first place, it is a part of our case that the discipline in this school is strict in an unusual degree. Not only is this universally recognized, but we have had to bear a great deal of obloquy for so rigidly maintaining out standard of scholarship. We expect our students to work hard for eight months, and we give them four months to do whatever they like in—to play tennis, to work on a railroad or in a shop, to lie under the trees, or to go yachting. We should not think of making so short a school year unless we

knew that we could secure continuous work during that time. You speak of our "robbing" our students of instruction they have a right to expect. Now, I desire to say emphatically that the pupils of the Massachusetts Institute of Technology receive instruction enough and do studying enough in the course of the year. Their attainments and acquirements on graduation are a sufficient proof of this. No more ought to be required; no more actually is required by any school. I don't care what the length of its terms. The only matter about which there can be any dispute is whether or not it would be better for our pupils to do this amount of work in a longer school year, with a shorter vacation.

To our view, what a man most needs, either as student or in professional practice, is the power of concentrating his energies and working vigorously while he does work. Protracting the year, with a

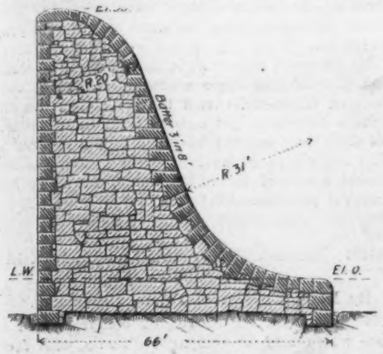

Fig. 5. Section of Completed Dam.

lower daily requirement, does not appear to us the way to form the best scholarly or professional habits. Moreover, we here have the notion, in which we may be mistaken, that the work a man does under a reasonable degree of pressure, with no time to waste, is likely to be a great deal better work than that which is done with no feeling of urgency. Personally, I can say, after 30 years of dealing with important affairs, that I consider this to be of the very essence of good work, or of good mental training; except only in artistic lines, of which I profess to know nothing. However this may be, the theory which has controlled the Massachusetts Institute of Technology in this matter from the beginning, in 1865, has been that the student should work strenuously, energetically, persistently, while he works, and then should be given a correspondingly long vacation in which to refresh himself, either by play, or by field or shop work, calling out a different set of faculties, perhaps in itself nearly as restful as play.

The foregoing is one reason why the faculty of the Institute has created a short school year with a long vacation. The other, and perhaps the more important reason, is one which relates to the pecuniary needs of our students. The young men who come to us are, as a rule, poorer than those who go to an ordinary classical college. A student coming to a school like this knows that, if he can possibly raise the money to get through, he will have his profession already acquired. Even if he only stays three or two years, he will have possessed himself of sufficient professional accomplishments to become a useful assistant on a railroad or in a machine shop. Consequently, students come to us who would not think of making the effort to enter a classical college and go to a professional school afterward. To such a body of young men, the opportunity afforded by a continuous mid-summer vacation of 16 weeks is very important; and, as a matter of fact, the students of the Massachusetts Institute of Technology avail themselves of it to a very large extent. I once took a census of the class who had just become juniors, and ascertained that precisely 70% of the total membership had during the summer vacation, worked at remunerative employment, in most cases of a professional nature, I presume this proportion was exceptionally high. Yet many of our students do this very thing each succeeding summer while they are at school, and thus obtain the means by which alone they would be able to continue their course over. It is true that in this way we lose some valuable men out of the school, who, having shown superior qualities in their summer work, receive and accept offers of permanent employment. Every year not a few drop out of our third and fourth year classes in this way. But even so, we are not disposed to quarrel with the result, for we find that the students who return to us do so almost invariably with heightened interest, arising from being able to see just why they are required to master certain tedious and laborious studies. Thus it comes about that this summer work not only furnishes needed means for continuing their courses at the Institute, but becomes a valuable reinforcement of the school year. For such a purpose a four months' vacation is twice as long as a three months' vacation would be. Even long as our vacation is, however, we find great difficulty in getting our students back promptly at the opening of the year, so many of them are engaged in professional and other work.

Such are the reasons why the faculty of the Institute have, down to this time, maintained a short school year and a long vacation. I can readily understand how others may look at the matter differently, especially if they have in mind schools with different needs and circumstances; but I cannot see why an institution taking this view should be arraigned as dealing unjustly with its students, much less why it should be charged with robbing them. These matters are all known in advance. Intending students acquaint themselves with the opportunities, requirements, etc., of different institutions; and, it may be presumed, select their college with reference thereto. I see no reason why we should not have colleges with long vacations and colleges with short vacations. Each may do its own peculiar work better so than in the other way.

Respectfully yours,
Francis A. Wilker.

Boston, Mass., Jan. 18, 1893.

(A clause relating to an entirely different subject is omitted from the end of this letter and will appear next week.—Ed.)

(1. As to the facts of the case. If there was any error it was not ours. The return of eight foolscap pages very kindly sent us from the Massachusetts Institute of Technology gave the length of both the civil and mechanical course as "four years of 33 weeks each," volunteering the further statement: "Four weeks of vacation work are also required in one year of the Civ. Eng. Course." In any case the error is not material, as it only changes the figures of 33 weeks of work and 19 of vacation to 34 and 18, respectively.

It is but fair to add here also, however, that Cornell got credit in our diagrams which it did not deserve. Its year was officially returned to us as 40 weeks in the mechanical department and 36 in the civil; but its catalogue shows only 34 weeks, the same as at the M. I. T. If, therefore, the one institution is blameworthy in this respect, the other is equally so.

2. As to the reason of the case. We did not charge that "the scale had generally been turned in favor of long vacations by the desire of the college professors to disport themselves at the seaside or the mountains." In a sense, we are ready to say so now, but we only charged that it was a "leading cause." This involves no worse charge than that the professors are human. Which of us can say that when some new proposition having both good and bad features, but greatly adding to our personal comfort, is laid before us we will not

Be to its faults a little blind;
Be to its virtues ever kind?

How much more will this be so when the proposition is to abandon some old practice which has not only comfort but custom in its favor?

The reasons advanced in favor of these short college years are, first, that by the "unusually strict discipline" as much is accomplished in eight months (7.85 months, to be accurate) as the M. I. T. or any other school can accomplish in 10 or 12 months. The attainments of the graduates is adduced as "sufficient proof of this." We deny the sufficiency of this proof. We have not been slow to recognize the merits of the school or of its graduates, but when alleged as proof that the M. I. T.

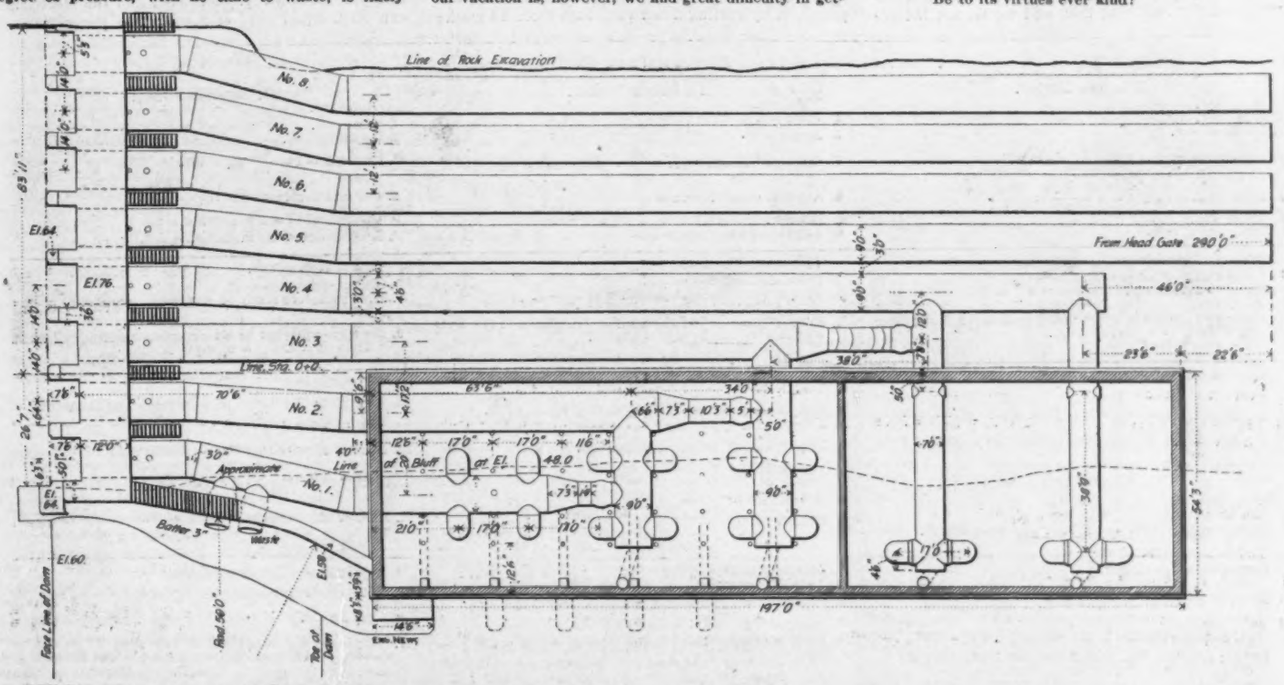

FIG. 6. PLAN OF PENSTOCK AND POWER HOUSE AT EAST END OF DAM.

student with and does accomplish in 30 weeks what the Kansas or the St. Louis student takes 40 weeks for, it becomes pertinent to advance, what will hardly be denied, that the M. I. T. has the best advantage even for engineering students in the country in the respect of thorough preparation, surrounding conditions, average means and natural aptitude.

We deny also the physiological truth of the plea itself. Of course the M. I. T. "expects its students to work hard for eight months"; so do all other schools, and nearly all of them expect also, and require, that they shall keep on doing so for a month or so longer. The students of every well managed school can do so perfectly well, for they are no more mentally exhausted at the end of the eighth (7.5th) month than at the end of the sixth or seventh. The only valid physiological plea for even a three-months vacation is the heat of the summer; for, though we believe and admit that the mental strain upon a hard-working student is on the whole greater than on the average brain-worker, the latter gets far less than one month's vacation, and the degree of mental exhaustion represented by even nine months of average work is surely more than made good by two or three months' vacation. No living or dead brain specialist, to our knowledge, has ever alleged the contrary. If so, giving students four (4.15) months to do nothing in is simply devoting a month or two of each year to educating them in habits of mental idleness.

Surely this goes far to invalidate the second reason advanced for short years—to teach the student "to work vigorously while he does work." We readily admit that "protracting the year with a lower daily requirement" would be unwise, or at least unquestionable wisdom. But this begs the question. Have the colleges with longer years lower daily requirements? We have no shadow of reason for believing this, and we do not believe direct this effort carefully along the line of least resistance.

The physiological argument in favor of short years, therefore, falls to the ground. So far as we are able to perceive, no part of it is sound. The second reason advanced is the pecuniary needs of the student. These in the abstract are probably less at the M. I. T. than at any other engineering school in the country; but as an argument applying in principle to all schools, it is alleged that 50 to 70% of some of the M. I. T. classes find work in their long vacations, in most cases profitable summer work. This argument is a perfect valid one, and it is further, with truth, alleged that the longer the vacation the better the chance for such work. Let us assume that 60% on an average get some paid vacation work, 40% of them in professionally instructive, as well as profitable, work.

But the 40-week colleges also have a large proportion of men who secure paid vacation work. We have taken pains to ascertain the experience of two of them in this respect, which is as follows:

Director Palmer C. Ricketts, of the Rensselaer Polytechnic Institute, writes us:

I should say that 25% to 35% of our students work during the summer, but this is somewhat of a guess, as I have not attempted to get accurate figures at any time.

Prof. J. B. Johnson telegraphs us from Washington University, St. Louis, an institution which till lately required five years of 40 weeks, or 200 weeks in all, before graduating:

All engineering students in the West who want it get paid for work in vacations; say, 90%.

This does not look as if four months vacation was necessary to secure a large proportion of the students opportunity for paid vacation work. But grant that only half as many would secure employment by cutting down vacations from 18 weeks (4.15 months) to 12 weeks (2.77 months)—which, by the way, is in the proportion of 2 to 3, and not of 2 months to 4. By making the vacation still longer a still greater advantage in this respect would result, and by any one of the following plans, without compelling any students to waste a month or two of each year in over-long vacations:

1. By putting the same number of weeks (136) into a three-year course, as at the Michigan Mining School, and advising the student to take an entire year in the middle of his course for practical work. (This is often the most judicious thing a student can do).

2. By putting the same number of weeks into a 3½-year course, as at the Worcester Polytechnic, and giving one extra long vacation in the course, or releasing them six months sooner.

3. By adding six weeks or so of solid field, drafting or shop work, 10 hours per day, six days in the week, at the end of each year, from which students could be excused if they were able to secure employment elsewhere.

This last would be similar to the plan just adopted at the Rensselaer Polytechnic, which extends its many course to 41 weeks per year. In fact, is a feature which should be added, in our judgment, to all engineering schools. No engineering school is quite what it should be without it. It would give the young graduates an immense advantage in getting a start, since single-day practice by no means gives the same insight into practical work.

The apparent net result is that there is no single argument of any force whatever for more than ten-week vacations, except that of giving the students a chance to get outside work in vacations, and that that end can be much better secured in other ways without involving such tremendous and general waste of time. Therefore, we think it a wrongful practice.—Ed.)

SOME MECHANICAL AND ELECTRICAL ANALOGIES.

*By D. F. Bedell and Dr. A. C. Crehore.**

No phenomena are so readily comprehended as those which may be compared directly with facts that are familiar, and no reasoning is so quickly grasped as reasoning "by analogy." The analogies between certain mechanical and electrical relations are so striking that when either relations are understood the others follow, and from the laws of mechanics we can readily write those of electricity. The process is a reversible one, and the electrician can with equal ease step over into the realms of

Analogies Between Mechanical and Electrical Computations.

I. Linear Motion.	II. Rotary Motion.	III. Electric Current.
Notation.	Notation.	Notation.
1. Time = t.	1. Time = t.	1. Time = t.
2. Distance = s.	2. Angle = φ.	2. Quantity = q.
3. Linear velocity = $v = \frac{ds}{dt}$. $ds = vdt$.	3. Angular velocity = $\omega = \frac{d\varphi}{dt}$. $d\varphi = \omega dt$.	3. Current = $i = \frac{dq}{dt}$. $dq = idt$.
4. Linear acceleration = $a = \frac{dv}{dt} = \frac{d^2s}{dt^2}$.	4. Angular acceleration = $\alpha = \frac{d\omega}{dt} = \frac{d^2\varphi}{dt^2}$.	4. Current acceleration = $\beta = \frac{di}{dt}$.
5. Mass = M.	5. Moment of inertia = I.	5. Coefficient of self induction = L.
6. Momentum = Mv.	6. Angular momentum = $I\omega$.	6. Electro-magnetic momentum = Li.
Frictional Resistance.	Frictional Resistance.	Ohmic Resistance.
7. Frictional resistance = F.	7. Frictional resistance = F.	7. Ohmic resistance = R.
8. Force to overcome resistance = $F_R = Fv$.	8. Torque to overcome resistance = $T_R = R\omega$.	8. Electromotive force to overcome resistance = $e_R = Ri$.
9. Energy expended in overcoming resistance in the time $dt = dW_R = F_R ds = Rv^2 dt$.	9. Energy expended in overcoming resistance in the time $dt = dW_R = T_R d\varphi = R\omega^2 dt$.	9. Energy expended in overcoming resistance in the time $dt = dW_R = e_R dq = Ri^2 dt$.
Inertia.	Inertia.	Self-induction.
10. Force to overcome inertia = $F' = Ma = M\frac{dv}{dt}$.	10. Torque to overcome inertia = $T' = I\alpha = I\frac{d\omega}{dt}$.	13. Electromotive force to overcome self-induction = $e' = L\beta = L\frac{di}{dt}$.
11. Kinetic energy acquired in the time $dt = dW' = F'ds = Mv\frac{dv}{dt}dt$.	11. Kinetic energy acquired in the time $dt = dW' = T'd\varphi = I\omega\frac{d\omega}{dt}dt$.	11. Energy acquired by the magnetic field in the time $dt = dW' = e'dq = Li\frac{di}{dt}dt$.
12. Kinetic energy = $W' = \int_0^v Mv\frac{dv}{dt}dt = \frac{1}{2}Mv^2$.	12. Kinetic energy = $W' = \int_0^\omega I\omega\frac{d\omega}{dt}dt = \frac{1}{2}I\omega^2$.	12. Energy of magnetic field = $W' = \int_0^i Li\frac{di}{dt}dt = \frac{1}{2}Li^2$.
Inertia plus Resistance.	Inertia plus Resistance.	Resistance plus Self-induction.
13. Total force applied = $F = F_R + F' = Rv + M\frac{dv}{dt}$.	13. Total torque applied = $T = T_R + T' = R\omega + I\frac{d\omega}{dt}$.	13. Total electromotive force applied = $e = e_R + e' = Ri + L\frac{di}{dt}$.
14. Total energy supplied in the time $dt = dW = dW_R + dW'$; or $Fds = F_R ds + F'ds$; or $Fvdt = Rv^2 dt + Mv\frac{dv}{dt}dt$.	14. Total energy supplied in the time $dt = dW = dW_R + dW'$; or $Td\varphi = T_R d\varphi + T'd\varphi$; or $T\omega dt = R\omega^2 dt + I\omega\frac{d\omega}{dt}dt$	14. Total energy supplied in the time $dt = dW = dW_R + dW'$; or $edq = e_R dq + e'dq$; or $eidt = Ri^2 dt + Li\frac{di}{dt}dt$.

It. We can readily believe that the M. I. T. and other high-grade schools direct given units of mental work to better advantage than some poorer schools, and some may know how to extract more units of effective mental work without overstrain. A gifted instructor acts upon the mind of the student as a band of music on a marcher. But much as we admire and respect the M. I. T. we are by no means ready to concede to it a monopoly or a leadership in these respects. To the best of our knowledge and belief, every college without exception aims to work its students, week by week, up to their limit of elasticity. Most of them must actually do so; no one can do more. Many of them besides the M. I. T., but with much longer years,

dynamics. To enable one to reason accurately in this manner and to reach definite results with absolute certainty, it is necessary to give with exactness the fundamental relations of mechanics and electricity. The following table is therefore given, showing the analogies between linear motion, motion of rotation and the electric current. Starting a current of electricity in a circuit is analogous to imparting motion to a body, and requires an impressed force. This force must overcome the resistance (electrical resistance corresponding to that of friction) and the inertia of the mass of current.

* From a treatise on "Alternating Currents," soon to be published by the authors.

In the case of the electric current this inertia is called "self-induction." A revolving fly-wheel may well represent the flow of electricity, its velocity corresponding to the current, its moment of inertia to the coefficient of self-induction, and the friction to ohmic resistance.

A study of the tables will make these analogies more clear. It is to be noted that the fly-wheel or moving mass in slowing down gives back its kinetic energy and the wheel is carried on, after the impressed force is removed, until this is entirely consumed in overcoming friction. Similarly, when the current diminishes upon the removal of the impressed electromotive force, the energy stored in the magnetic field is restored to the circuit, and the current keeps flowing until the energy is entirely used up in overcoming the ohmic resistance.

The Niagara Water Power Tunnel has cost $1,625,000, under the contract with Rodgers & Clement, says a press item. The cost of wheel pit, tunnel extension, lining, etc., added, makes the total estimated cost $1,825,000.

An improvement in the gun of Dr. Richard J. Gatling is announced by the inventor, which increases the rapidity of fire from "000 to 2,000 shots per minute." The new cartridge feeding process includes a belt driven by an electric motor. No details are yet given out.

The Rensselaer Polytechnic Institute Alumni Association, of New York city, was organized Jan. 17, and the following officers elected: President, F. Collingwood; Vice-President, B. C. Gowing; Secretary and Treasurer, G. A. Just; Directors, Theo. W. Davis, W. A. Averigg, and A. A. Wigand. There are over 125 alumni in the vicinity of New York.

The total cost of the state canals of New York, from their inception, says State Engineer Schenck, in his last report, has been $117,843,000, including construction, maintenance and operation. The total revenue derived is $123,575,000; but the abandoned canals have been operated at a loss of $18,450,000, making a net loss to the state from its canal system of $2,718,000. These figures, however, do not include the interest paid on the canals or interest from invested canal revenue.

The construction of freight car truck frames is being investigated by a committee of the Master Car Builders' Association. A circular letter has been sent out asking opinions of members as to the relative merits of rigid and swing motion trucks, pressed steel, malleable and cast center-plates, wooden and compound bolsters, wooden and metal transoms, pressed steel and diamond truck frames, inside hung and outside hung brakes, wooden and metal brake beams and many other details of truck construction.

The final arguments in the suit of the Westinghouse Air Brake Co. against the New York Air Brake Co. were presented this week before Judge Townsend in the U. S. Circuit Court, in New York city. Messrs. Geo. H. Christy, of Pittsburgh, and Frederic H. Betts, of New York, presented the Westinghouse Air Brake Co.'s case, and Messrs. Maynardier and Brown appeared on behalf of the New York Air Brake Co. The principal point at issue is whether the quick-acting triple-valve of the New York Co. infringes the patent granted to Geo. Westinghouse in 1885. The defendant claims that its valve is covered by an older Westinghouse patent (No. 162,465), which referred to the method of securing the quick release of a straight air-brake by venting the train pipe at each car, and which has now expired. On this ground it holds that its valve does not infringe the later Westinghouse patents.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

WESTERN MARYLAND.—The grading on the line from Porter's Siding to York, Pa., 15 miles, has been nearly completed and tracklaying is finished to Spring Grove. It is expected to have the entire line in operation of this railway from Findlay to New London, O.

FINDLAY, FT. WAYNE & WESTERN.—The citizens of New London, O., are endeavoring to secure an extension of this railway from Findlay to New London, O., about 66 miles.

TOLEDO & OHIO CENTRAL.—Gen. Man. T. M. Ferris is reported as saying: "The T. & O. C. is now ready to build a line from Columbus to Ridgeway. All necessary arrangements have been completed, and the engineers are now in the field, preparing for the construction, which will be commenced as soon as the weather will permit in the spring."

BANGOR & AROOSTOOK.—The following account of the progress of work on this Maine railway was given by Pres. A. A. Burleigh in a recent newspaper interview. The road is projected to run from Brownsville, Me., to Van Buren, Me., 175 miles, with branches from Ft. Fairfield to Easton, Me., 12 miles, and from Dyer Brook to Ashland, Me., 43 miles. C. P. Treat, of Chicago, Ill., is the contractor:

"All is going well with the road builders, and when the line is complete it will be something to be proud of, for it is being very thoroughly constructed. There are still about 500 men at work on the line and the only work suspended is that on sections where very little will have to be done. The crews on the ledges are getting on as fast as in the warm weather. Grading ready for sleepers and rails has been completed for six miles above Brownsville, also nearly all of the masonry work. The heavy stone work at the Canadian Pacific crossing at Mill Brook is complete, the latter being a 400-ft. foundation for an iron trestle. On the other end of the line the grading has been done from Stacyville to a point 2½ miles above Houlton, the whole distance being 40 miles. Of this distance, 20 miles of grading are complete, and it includes the heaviest work on the whole line. An arched culvert has been built at Limestone Brook. This culvert is in a fill of 34 ft. in depth, requiring 20,000 cu. yds. of earth. Before reaching that point a cut was made through the horseback which forms a part of the divide between the Penobscot and St. John waters. This cut is 400 ft. long and from 12 to 18 ft. deep, most of which is a solid ledge. At Houlton a heavy cut has been made through a horseback 60 ft. deep. About 50,000 cu. yds. of earth were removed. North of Houlton the right of way through to Caribou has been cleared, also most of the way up to the Fort Fairfield branch. None of the light work on the line has been done in order that as many miles of the road as possible might be built, but the very heaviest has been selected and the most difficult sections of the line are graded and ready for the ballast. Thus far between $200,000 and $400,000 have been expended. This includes the cost of the preliminary and final surveys and the right of way expenses, besides what has been paid for grading, etc. I have been all over the line, and when in Aroostook Co. the County Commissioners were with me and they expressed themselves as pleased with the amount and quality of work done. They have accepted two 5-mile sections of the road and paid the company $20,000 a section as agreed upon. They say that the grading is much better than they expected and better than the company promised. No grade thus far exceeds 17, or 53.8 ft. to the mile, and none will when the road is completed. It is our intention to complete the road this year, and there is practically no doubt that it will be done. Of course, the work will be pushed more rapidly in the spring, and as soon as the weather moderates enough it will be especially pushed between Brownsville and the Aroostook line. We have had good success with all of our contractors. The locating engineers have been at work all the time since the survey was completed and are still on the line making changes in alignment and grades. One change is being made in Penobscot County which will cut down the summit and save a big expense. I believe the Bangor & Aroostook road will have the longest tangent in the state. There is a piece of perfectly straight road in Stacyville, Sherman and Crystal, 12 miles long. It goes entirely across Stacyville and Sherman and nearly across Crystal. One good feature of the roadbed will be its width of 20 ft. and the 16 ft. top, which will hold the ballast well and save much repairing each year. There will be 12 ins. of ballast and the work of laying it will be begun as soon as the frost is out of the ground."

WILKES BARRE & EASTERN.—This company has awarded the contract for the erection of a heavy timber trestle, over one mile in length near Wilkes Barre, Pa., to Mairs & Lewis, 16 Broadway, New York. This firm is also constructing 6,000 ft. of trestle at Niagara Falls for the Niagara Falls Junction R. R., and has the contract for the Catskill & Tannersville R. R., which connects the Otis Elevating Ry. and the Kaaterskill Ry., and is about 1½ miles long. Charles P. Parker, 14 Nassau St., New York, Cnf. Engr.

Projects and Surveys.

GRANITE.—This company has been chartered in Pennsylvania to build a railway from Granite Station, on the Baltimore & Harrisburg R. R., to Granite Hill, one mile. Pres., David Wills, Gettysburg, Pa.

LEHIGH & PAVILION.—This company, recently chartered in New York, proposes to build a railway from Le Roy, N. Y., south to the junction of the Delaware, Lackawanna & Western, and Buffalo, Rochester & Pittsburg railways near Pavilion. Among the directors are: Robt. E. Sayre, New Bethlehem, Pa.; E. L. Fuller, Scranton, Pa.; Chas. H. Rood, Le Roy, N. Y., and Arthur G. Yates, Rochester, N. Y.

DETROIT, PONTIAC & NORTHERN.—This company whose incorporation was noted in our issue of Jan. 12, proposes to build a railway from Pontiac to Detroit, Mich. The projectors are stated to be stockholders of the Pontiac, Oxford & Northern R. R. Co.

EBENSBURG & BLACK LICK.—Chartered in Pennsylvania to build a railway from a point on the Cambria & Clearfield R. R., near Ebensburg, Pa., to a point on the Indiana Branch of the Pennsylvania R. R., near Black Station, a distance of about 35 miles; Pres., Henry D. Welch, Philadelphia, Pa.

Southern.—Existing Roads.

HOLSTON VALLEY.—This company has let the contract for grading and trestling its proposed railway from Bluff City, Tenn., to Damascus, Va., about 25 miles, to Smalling & Co., of Watauga, Tenn.

MONTGOMERY, HAYNEVILLE & CAMDEN.—About 10½ miles of this railway from Camden to Montgomery, Ala., 73 miles have been graded and the work has been discontinued on account of lack of funds. It is expected that the money necessary to continue the work will be obtained soon and the grading resumed in the spring. Pres., Sol. D. Bloch, Camden, Ala.

Projects and Surveys.

BRUNSWICK, WESTERN & SOUTHERN.—It is announced that this railway, projected to run from Southport to Meares Bluff, N. C., will be built immediately by the Cape Fear Harbor & Coal Co. Work on the road is to be commenced within 20 days and is expected to be completed in three months.

LOCKHART SHOALS.—The surveys are nearly completed for the 16-mile line from Jonesville to Lockhart Shoals, S. C., and it is stated that the contract for construction will soon be awarded. Pres., C. D. Farrar, Union, S. C.

DRY FORK.—Ch. Engr. John W. Moore has received orders to begin the location of the line of this proposed railway from the West Virginia Central & Pittsburg R. R. near Hendricks, W. Va., along the Cheat River as far as the headwaters of the Greenbrier River, and to prepare plans and specifications upon which bids may be received. The preliminary survey for this section of the road was made some time ago.

ROWLESBURG & OHIOPYLE.—A press dispatch says: "The proposed railroad from Rowesburg, W. Va., to Ohiopyle, Pa., via Bruceton and Clifton Mills, W. Va., and Ellottsville, Pa., is once more talked of. The route has been surveyed from Rowlesburg nearly to Ellottsville, and is considered a very good one and an easy one to build. It will pass through some of the richest coal and iron fields in West Virginia and Pennsylvania, and give easy access to the timber of the adjoining mountains."

Northwest.—Existing Roads.

INDIANA, ILLINOIS & IOWA.—A meeting of the stockholders of this company will be held on March 3, to vote an issue of $700,000 of bonds to build the proposed extension from Knox to South Bend, Ind., about 40 miles.

AHNAPEE & WESTERN.—Work has been discontinued on the extension from Ahnapee to Sturgeon Bay, Wis., 20 miles, on account of the cold weather.

WINONA, MARSHALLTOWN & SOUTHERN R. R. & COAL CO.—This company has been chartered in Iowa to extend the Winona & Southwestern R. R. from Orage, Ia., through Marshalltown, Chariton, and the coal fields of Southern Iowa to a connection with the railway lines of the Southwest. The directors are: N. S. Ketchum, G. F. Kirby, C. C. Gilman, and A. G. Glick.

DULUTH, SOUTH SHORE & ATLANTIC.—Ch. Engr., H. J. Payne, Marquette, Mich., writes as follows: "Regular freight and passenger trains are now running on the Iron River extension of this road. The extension is 41.2 miles long and was completed in 1891. The contracts were let to Henry, Balch & Peppard, of Minneapolis, Minn. in July, 1891, and the grading was completed about Nov. 1. From August to November about 1,000 men were employed. Tracklaying was begun Oct. 1, and completed Nov. 24, and the road was opened for traffic Dec. 4, 1892. The work was medium; maximum grade 42 ft. per mile and maximum curve 4°."

Projects and Surveys.

MANKATO & NORTHEASTERN.—It is officially stated that active construction on this railway from Mankato to Farmington, Minn., 20 miles, will be begun at Mankato soon; Pres., F. R. Carney, Mankato, Minn.

CHICAGO, GRAND CITY & TERRE HAUTE.—Chartered in Illinois to build a railway from Chicago to Grand City and Terre Haute, Ind. Among the incorporators are: Isaac T. Dyer, W. R. Pyne, Chas. J. Strawberg, A. J. McDonald, and others of Chicago.

CHICAGO & HAMMOND.—Chartered in Illinois to build a railway from Chicago to a point on the Indiana line. Among the incorporators are, Frank H. Brown, Albert H. Valentine, Wm. F. Black, and others.

Southwest.—Existing Roads.

TEXAS CENTRAL.—The preliminary survey for the proposed branch from Rose to Waco, Tex., has been begun under the direction of Wm. T. Gould, Tex. Engr., Waco, Tex.

GULF, COLORADO & SANTA FE.—A movement is on foot to secure an extension from Ballinger City to Abilene, Tex. The bonus required by the company has been subscribed, and it is expected that work will begin soon. The line will be about 55 miles long.

MISSOURI PACIFIC.—It is stated that right of way is being secured for the line of the Southwest City & Joplin Ry., which is projected to run from Joplin, Mo., to Southwest City, Mo.

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UNION SECURITY CO.—A press dispatch says: "At last there seems to be some prospect of a completion of the Winner bridge and also a large portion of the road which was laid out in connection with the scheme. At a meeting of the bond and stockholders held recently a company was organized to be known as the Union Security Company with a capital of $400,000, which will buy the bridge, terminals and railway at the sale to be held Feb. 4. The intention is for the new company to issue first mortgage bonds to the amount of $1,500,000 secured on the entire railway and bridge property and to fund what money has already been put into the enterprises in a series of $2,500,000 of second mortgage bonds which are to be held by the present owners of the bonds and stock. The first mortgage bonds will be sold and the money thus realized will be used to complete the bridge and the railway. It is estimated that the work necessary for the completion of the bridge and the building of the railway to the proposed northern terminus near the Iowa line will cost about $400,000. Theodore S. Bates, who presided at the meeting, will probably be made president of the security company and will carry out the work of completion. It is understood that the security company will complete the bridge and railway simply in order to sell them."

Projects and Surveys.

LUFKIN SOUTH AND SOUTHEASTERN.—Secy. E. F. Bonner, Lufkin, Tex., writes that the surveys will be begun in April or May for this railway from Lufkin to Rockland, Tex., 20 miles. The officers of the company are: Pres., E. J. Mantooth; Vice-Pres., S. W. Henderson; Asst., Sam Wiener; Secy. and Treas., B. F. Bonner; Gen. Man., J. H. Kurth.

NORTHERN ARKANSAS.—This company has been incorporated in Arkansas with a capital stock of $100,000. The officers are: P. Arland, Pres.; R. D. Welch, Vice-Pres. and Gen. Man.; C. C. Buford, Secy., and H. C. King, Treas. Mammoth Springs, Ark., will be the place of business. The company proposes to build and operate a railway, build water-works, electric light plants and street railways. The railway is to commence at or near Ravenden Station, Lawrence Co., on the line of the Kansas City, Fort Scott & Memphis Ry., and run to the town of Ravenden Springs, Randolph Co.

student will and does accomplish in 34 weeks what the Rensselaer or the St. Louis student takes 40 weeks for, it becomes pertinent to adduce, what will hardly be denied, that the M. I. T. has the best drainage area for engineering students in the country in the respect of thorough preparation, surrounding conditions, average means and natural aptitude.

We deny also the physiological truth of the plea itself. Of course the M. I. T. "expects its students to work hard for eight months"; so do all other schools; and nearly all of them expect also, and require, that they shall keep on doing so for a month or so longer. The students of every well managed school can do so perfectly well, for they are no more mentally exhausted at the end of the eighth (7.85th) month than at the end of the sixth or seventh. The only valid physiological plea for even a three-months vacation is the heat of the summer; for, though we believe and admit that the mental strain upon a hard-working student is on the whole greater than on the average brain-worker, the latter gets far less than one month's vacation, and the degree of mental exhaustion represented by even nine months of average work is surely more than made good by two or three months' vacation. No living or dead brain specialist, to our knowledge, has ever alleged the contrary. If so, giving students four (4.15) months to do nothing in is simply devoting a month or two of each year to educating them in habits of mental idleness.

Surely this goes far to invalidate the second reason advanced for short years—to teach the student "to work vigorously while he does work." We readily admit that "protracting the year with a lower daily requirement" would be unwise, or at least unquestionable wisdom. But this begs the question. Have the colleges with longer years lower daily requirements? We have no shadow of reason for believing this, and we do not believe direct this effort usefully along the line of least resistance.

The physiological argument in favor of short years, therefore, falls to the ground. So far as we are able to perceive, no part of it is sound. The second reason advanced is the pecuniary needs of the student. These in the abstract are probably less at the M. I. T. than at any other engineering school in the country; but as an argument applying in principle to all schools, it is alleged that 60 to 70% of some of the M. I. T. classes find work in their long vacations, in most cases professional work. This argument is a perfect valid one, and it is further, with truth, alleged that the longer the vacation the better the chance for such work. Let us assume that 60% on an average get some paid vacation work, 50% of them in professionally instructive, as well as profitable, work.

But the 40-week colleges also have a large proportion of men who secure paid vacation work. We have taken pains to ascertain the experience of two of them in this respect, which is as follows:

Director Palmer C. Ricketts, of the Renssalaer Polytechnic Institute, writes us:

> I should say that 25% to 35% of our students work during the summer, but this is somewhat of a guess, as I have not attempted to get accurate figures at any time.

Prof. J. B. Johnson telegraphs us from Washington University, St. Louis, an institution which till lately required five years of 40 weeks, or 200 weeks in all, before graduating:

> All engineering students in the West who want it get paid for work in vacations; say, 90%.

This does not look as if four months vacation was necessary to secure a large proportion of the students opportunity for paid vacation work. But grant that only half as many would secure employment by cutting down vacations from 18 weeks (4.15 months) to 12 weeks (2.77 months)—which, by the way, is in the proportion of 2 to 3, and not of 3 months to 4. By making the vacation still longer a still greater advantage in this respect would result, and by any one of the following plans, without compelling any students to waste a month or two of each year in over-long vacations:

1. By putting the same number of weeks (136) into a three-year course, as at the Michigan Mining School, and advising the student to take an entire year in the middle of his course for practical work. (This is often the most judicious thing a student can do).

2. By putting the same number of weeks into a 3½-year course, as at the Worcester Polytechnic, and giving one extra long vacation in the course, or releasing them six months sooner.

3. By adding six weeks or so of solid field, drafting or shop work, 10 hours per day, six days in the week, at the end of each year, from which students could be excused if they were able to secure employment elsewhere.

This last would be similar to the plan just adopted at the Rensselaer Polytechnic, which extends its mean course to 41 weeks per year. In fact, is a feature which should be added, in our judgment, to all engineering schools. No engineering school is quite what it should be without it. It would give the young graduates an immense advantage in getting a start, since single-day practice by no means gives the same insight into practical work.

The apparent net result is that there is no single argument of any force whatever for more than ten-week vacations, except that of giving the students a chance to get outside work in vacations, and that that end can be much better secured in other ways without involving such tremendous and general waste of time. Therefore, we think it a wrongful practice.—Ed.)

SOME MECHANICAL AND ELECTRICAL ANALOGIES.

By D. F. Bedell and Dr. A. C. Crehore.*

No phenomena are so readily comprehended as those which may be compared directly with facts that are familiar, and no reasoning is so quickly grasped as reasoning "by analogy." The analogies between certain mechanical and electrical relations are so striking that when either relations are understood the others follow, and from the laws of mechanics we can readily write those of electricity. The process is a reversible one, and the electrician can with equal ease step over into the realms of dynamics. To enable one to reason accurately in this manner and to reach definite results with absolute certainty, it is necessary to give with exactness the fundamental relations of mechanics and electricity. The following table is therefore given, showing the analogies between linear motion, motion of rotation and the electric current. Starting a current of electricity in a circuit is analogous to imparting motion to a body, and requires an impressed force. This force must overcome the resistance (electrical resistance corresponding to that of friction) and the inertia of the mass or current.

Analogies Between Mechanical and Electrical Computations.

I. Linear Motion.	II. Rotary Motion.	III. Electric Current.
Notation.	Notation.	Notation.
1. Time = t.	1. Time = t.	1. Time = t.
2. Distance = s.	2. Angle = φ.	2. Quantity = q.
3. Linear velocity = $v = \frac{ds}{dt}$. $ds = vdt$.	3. Angular velocity = $\omega = \frac{d\varphi}{dt}$. $d\varphi = \omega dt$.	3. Current = $i = \frac{dq}{dt}$. $dq = idt$.
4. Linear acceleration = $a = \frac{dv}{dt} = \frac{d^2s}{dt^2}$.	4. Angular acceleration = $\alpha = \frac{d\omega}{dt} = \frac{d^2\varphi}{dt^2}$	4. Current acceleration = $\beta = \frac{di}{dt}$.
5. Mass = M.	5. Moment of inertia = I.	5. Coefficient of self-induction = L.
6. Momentum = Mv.	6. Angular momentum = $I\omega$.	6. Electro-magnetic momentum = Li.
Frictional Resistance.	Frictional Resistance.	Ohmic Resistance.
7. Frictional resistance = R.	7. Frictional resistance = R.	7. Ohmic resistance = R.
8. Force to overcome resistance = $F_R = Rv$.	8. Torque to overcome resistance = $T_R = R\omega$	8. Electromotive force to overcome resistance = $e_R = Ri$.
9. Energy expended in overcoming resistance in the time $dt = dW_R = F_R ds = Rv^2 dt$.	9. Energy expended in overcoming resistance in the time $dt = dW_R = T_R d\varphi = R\omega^2 dt$.	9. Energy expended in overcoming resistance in the time $dt = dW_R = e_R dq = Ri^2 dt$.
Inertia.	Inertia.	Self-induction.
10. Force to overcome inertia = $F^1 = Ma = M\frac{dv}{dt}$.	10. Torque to overcome inertia = $T^1 = I\alpha = I\frac{d\omega}{dt}$.	10. Electromotive force to overcome self-induction = $e^1 = L\beta = L\frac{di}{dt}$.
11. Kinetic energy acquired in the time $dt = dW^1 = F^1 ds = Mv\frac{dv}{dt}dt$.	11. Kinetic energy acquired in the time $dt = dW^1 = T^1 d\varphi = I\omega\frac{d\omega}{dt}dt$.	11. Energy acquired by the magnetic field in the time $dt = dW^1 = e^1 dq = Li\frac{di}{dt}dt$.
12. Kinetic energy = $W^1 = \int_0^v Mv\frac{dv}{dt}dt = \frac{1}{2}Mv^2$.	12. Kinetic energy = $W^1 = \int_0^\omega I\omega\frac{d\omega}{dt}dt = \frac{1}{2}I\omega^2$.	12. Energy of magnetic field = $W^1 = \int_0^i Li\frac{di}{dt}dt = \frac{1}{2}Li^2$.
Inertia plus Resistance.	Inertia plus Resistance.	Resistance plus Self-induction.
13. Total force applied = $F = F_R + F^1 = Rv + M\frac{dv}{dt}$.	13. Total torque applied = $T = T_R + T^1 = R\omega + I\frac{d\omega}{dt}$.	13. Total electromotive force applied = $e = e_R + e^1 = Ri + L\frac{di}{dt}$.
14. Total energy supplied in the time $dt = dW = dW_R + dW^1$; or $Fds = F_R ds + F^1 ds$; or $Fvdt = Rv^2 dt + Mv\frac{dv}{dt}dt$.	14. Total energy supplied in the time $dt = dW = dW_R + dW^1$; or $Td\varphi = T_R d\varphi + T^1 d\varphi$; or $T\omega dt = R\omega^2 dt + I\omega\frac{d\omega}{dt}dt$	14. Total energy suppplied in the time $dt = dW = dW_R + dW^1$; or $edq = e_R dq + e^1 dq$; or $eidt = Ri^2 dt + Li\frac{di}{dt}dt$.

* From a treatise on "Alternating Currents," soon to be published by the authors.

In the case of the electric current this inertia is called "self-induction." A revolving fly-wheel may well represent the flow of electricity, its velocity corresponding to the current, its moment of inertia to the coefficient of self-induction, and the friction to ohmic resistance.

A study of the tables will make these analogies more clear. It is to be noted that the fly-wheel or moving mass in slowing down gives back its kinetic energy and the wheel is carried on, after the impressed force is removed, until this is entirely consumed in overcoming friction. Similarly, when the current diminishes upon the removal of the impressed electromotive force, the energy stored in the magnetic field is restored to the circuit, and the current keeps flowing until the energy is entirely used up in overcoming the ohmic resistance.

The Niagara Water Power Tunnel has cost $1,025,000, under the contract with Rodgers & Clement, says a press item. The cost of wheel pit, tunnel extension, lining, etc., added, makes the total estimated cost at $1,825,000.

An improvement in the gun of Dr. Richard J. Gatling is announced by the inventor, which increases the rapidity of fire from "600 to 2,000 shots per minute." The new cartridge feeding process includes a belt driven by an electric motor. No details are yet given out.

The Rensselaer Polytechnic Institute Alumni Association, of New York city, was organized Jan. 17, and the following officers elected: President, F. Collingwood; Vice-President, B. C. Gowing; Secretary and Treasurer, G. A. Just; Directors, Theo. W. Davis, W. A. Ayerigg, and A. A. Wigand. There are over 125 alumni in the vicinity of New York.

The total cost of the state canals of New York, from their inception, says State Engineer Schenck, in his last report, has been $117,843,000, including construction, maintenance and operation. The total revenue derived is $133,575,000; but the abandoned canals have been operated at a loss of $18,450,000, making a net loss to the state from its canal system of $2,778,000. These figures, however, do not include the interest paid on the canals or interest from invested canal revenue.

The construction of freight car truck frames is being investigated by a committee of the Master Car Builders' Association. A circular letter has been sent out asking opinions of members as to the relative merits of rigid and swing motion trucks, pressed steel, malleable and cast center-plates, wooden and compound bolsters, wooden and metal transoms, pressed steel and diamond truck frames, inside hung and outside hung brakes, wooden and metal brake beams and many other details of truck construction.

The final arguments in the suit of the Westinghouse Air Brake Co. against the New York Air Brake Co. were presented this week before Judge Townsend in the U. S. Circuit Court, in New York city. Messrs. Geo. H. Christy, of Pittsburgh, and Frederic H. Betts, of New York, presented the Westinghouse Air Brake Co.'s case, and Messrs. Maynardier and Brown appeared on behalf of the New York Air Brake Co. The principal point at issue is whether the quick-acting triple-valve of the New York Co. infringes the patent granted to Geo. Westinghouse in 1885. The defendant claims that its valve is covered by an older Westinghouse patent (No. 162,465), which referred to the method of securing the quick release of a straight air-brake by venting the train pipe at each car, and which has now expired. On this ground it holds that its valve does not infringe the later Westinghouse patents.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

WESTERN MARYLAND.—The grading on the line from Porter's Siding to York, Pa., 15 miles, has been nearly completed and tracklaying is finished to Spring Grove. It is expected to have the entire line in operation of this railway from Findlay to New London, O.

FINDLAY, FT. WAYNE & WESTERN.—The citizens of New London, O., are endeavoring to secure an extension of this railway from Findlay to New London, O., about 66 miles.

TOLEDO & OHIO CENTRAL.—Gen. Man. T. M. Ferris is reported as saying: "The T. & O. C. is now ready to build a line from Columbus to Ridgeway. All necessary arrangements have been completed, and the engineers are now in the field, preparing for the construction, which will be commenced as soon as the weather will permit in the spring."

BANGOR & AROOSTOOK.—The following account of the progress of work on this Maine railway was given by Pres. A. A. Burleigh in a recent newspaper interview. The road is projected to run from Browsville, Me., to Van Buren, Me., 175 miles, with branches from Ft. Fairfield to Easton, Me., 12 miles, and from Dyer Brook to Ashland, Me., 43 miles. C. P. Trest, of Chicago, Ill., is the contractor:

"All is going well with the road builders, and when the line is complete it will be something to be proud of, for it is being very thoroughly constructed. There are still about 500 men at work on the line and the only work suspended is that on sections where very little will have to be done. The crews on the ledges are getting on as fast as in the warm weather. Grading ready for sleepers and rails has been completed for six miles above Brownsville, also nearly all of the masonry work. The heavy stone work at the Canadian Pacific crossing at Mill Brook is complete, the latter being a 400-ft. foundation for an iron trestle. On the other end of the line the grading has been done from Stacyville to a point 2½ miles above Houlton, the whole distance being 40 miles. Of this distance, 30 miles of grading are complete, and it includes the heaviest work on the whole line. An arched culvert has been built at Limestone Brook. This culvert is in a fill of 34 ft. in depth, requiring 20,000 cu. yds. of earth. Before reaching that point a cut was made through the horseback which forms a part of the divide between the Penobscot and St. John waters. This cut is 400 ft. long and from 12 to 18 ft. deep, most of which is a solid ledge. At Houlton a heavy cut has been made through a horseback 60 ft. deep. About 30,000 cu. yds. of earth were removed. North of Houlton the right of way through to Carlson has been cleared, also most of the way up to the Fort Fairfield branch. None of the light work on the line has been done in order that as many miles of the road as possible might be built, but the very heaviest has been selected and the most difficult sections of the line are graded and ready for the ballast. Thus far between $300,000 and $400,000 have been expended. This includes the cost of the preliminary and final surveys and the right of way expenses, besides what has been paid for grading, etc. I have been all over the line, and when in Aroostook Co. the County Commissioners were with me and they expressed themselves as pleased with the amount and quality of work done. They have accepted two 5-mile sections of the road and paid the company $20,000 a section as agreed upon. They say that the grading is much better than they expected and better than the company promised. No grade thus far exceeds 1%, or 53.8 ft. to the mile, and none will when the road is completed. It is our intention to complete the road this year, and there is practically no doubt that it will be done. Of course, the work will be pushed more rapidly in the spring, and as soon as the weather moderates enough it will be especially pushed between Brownsville and the Aroostook line. We have had good success with all of our contractors. The locating engineers have been at work all the time since the survey was completed and are still on the line making changes in alignment and grades. One change is being made in Penobscot County which will cut down the summit and save a big expense. I believe the Bangor & Aroostook road will have the longest tangent in the state. There is a piece of perfectly straight road in Stacyville, Sherman and Crystal, 12 miles long. It goes entirely across Stacyville and Sherman and nearly across Crystal. One good feature of the roadbed will be its width of 20 ft. and the 16 ft. top, which will hold the ballast well and save much repairing each year. There will be 12 ins. of ballast and the work of laying it will be begun as soon as the frost is out of the ground."

WILKES BARRE & EASTERN.—This company has awarded the contract for the erection of a heavy timber trestle, over one mile in length near Wilkes Barre, Pa., to Maire & Lewis, 18 Broadway, New York. This firm is also constructing 6,000 ft. of trestle at Niagara Falls for the Niagara Falls Junction R. R., and has the contract for the Catskill & Tannersville R. R., which connects the Otis Elevating Ry. and the Kaaterskill Ry., and is about 1½ miles long. Charles F. Parker, 14 Nassau St., New York, Chf. Engr.

Projects and Surveys.

GRANITE.—This company has been chartered in Pennsylvania to build a railway from Granite Station, on the Baltimore & Harrisburg R. R., to Granite Hill, one mile. Pres., David Wills, Gettysburg, Pa.

LEHIGH & PAVILION.—This company, recently chartered in New York, proposes to build a railway from Le Roy, N. Y., south to the junction of the Delaware, Lackawanna & Western, and Buffalo, Rochester & Pittsburg railways near Pavilion. Among the directors are: Robt. Sayre, New Bethlehem, Pa.; E. L. Fuller, Scranton, Pa.; Chas. H. Root, Le Roy, N. Y., and Arthur G. Yates, Rochester, N. Y.

DETROIT, PONTIAC & NORTHERN.—This company, whose incorporation was noted in our issue of Jan. 12, proposes to build a railway from Pontiac to Detroit, Mich. The projectors are stated to be stockholders of the Pontiac, Oxford & Northern R. R. Co.

EBENSBURG & BLACK LICK.—Chartered in Pennsylvania to build a railway from a point on the Cambria & Clearfield R. R., near Ebensburg, Pa., to a point on the Indiana Branch of the Pennsylvania R. R., near Black Station, a distance of about 35 miles; Pres., Henry D. Welch, Philadelphia, Pa.

Southern.—Existing Roads.

HOLSTON VALLEY.—This company has let the contract for grading and trestling its proposed railway from Bluff City, Tenn., to Damascus, Va., about 25 miles, to Smalling & Co., of Watauga, Tenn.

MONTGOMERY, HAYNEVILLE & CAMDEN.—About 10½ miles of this railway from Camden to Montgomery, Ala., 78 miles have been graded and the work has been discontinued on account of lack of funds. It is expected that the money necessary to continue the work will be obtained soon and the grading resumed in the spring. Pres., Sol. D. Bloch, Camden, Ala.

Projects and Surveys.

BRUNSWICK, WESTERN & SOUTHERN.—It is announced that this railway, projected to run from Southport to Meares Bluff, N. C., will be built immediately by the Cape Fear Harbor & Coal Co. Work on the road is to be commenced within 20 days and is expected to be completed in three months.

LOCKHART SHOALS.—The surveys are nearly completed for the 16-mile line from Jonesville to Lockhart Shoals, S. C., and it is stated that the contract for construction will soon be awarded. Pres., C. D. Farrar, Union, S. C.

DRY FORK.—Ch. Engr. John W. Moore has received orders to begin the location of the line of this proposed railway from the West Virginia Central & Pittsburg R. R. near Hendricks, W. Va., along the Cheat River as far as the headwaters of the Greenbrier River, and to prepare plans and specifications upon which bids may be received. The preliminary survey for this section of the road was made some time ago.

ROWLESBURG & OHIOPYLE.—A press dispatch says: "The proposed railroad from Rowesburg, W. Va., to Ohiopyle, Pa., via Bruceton and Clifton Mills, W. Va., and Elliottsville, Pa., is once more talked of. The route has been surveyed from Rowlesburg nearly to Elliottsville, and is considered a very good one and an easy one to build. It will pass through some of the richest coal and iron fields in West Virginia and Pennsylvania, and give easy access to the timber of the adjoining mountains."

Northwest.—Existing Roads.

INDIANA, ILLINOIS & IOWA.—A meeting of the stockholders of this company will be held on March 3, to vote an issue of $500,000 of bonds to build the proposed extension from Knox to South Bend, Ind., about 40 miles.

AHNAPEE & WESTERN.—Work has been discontinued on the extension from Ahnapee to Sturgeon Bay, Wis., 20 miles, on account of the cold weather.

WINONA, MARSHALLTOWN & SOUTHERN R. R. & COAL CO.—This company has been chartered in Iowa to extend the Winona & Southwestern R. R. from Orage, Ia., through Marshalltown, Chariton, and the coal fields of Southern Iowa to a connection with the railway lines of the Southwest. The directors are: N. S. Ketchum, G. F. Kirby, C. C. Gilman, and A. G. Glick.

DULUTH, SOUTH SHORE & ATLANTIC.—Ch. Engr., H. J. Payne, Marquette, Mich., writes as follows: "Regular freight and passenger trains are now running on the Iron River extension of this road. The extension is 41.2 miles long and was completed in 1891. The contracts were let to Henry, Balch & Peppard, of Minneapolis, Minn., in July, 1891, and the grading was completed about Nov. 1. From August to November about 1,000 men were employed. Tracklaying was begun Oct. 1, and completed Nov. 24, and the road was opened for traffic Dec. 4, 1892. The work was medium; maximum grade 42 ft. per mile and maximum curve 4°."

Projects and Surveys.

MANKATO & NORTHEASTERN.—It is officially stated that active construction on this railway from Mankato to Farmington, Minn., 50 miles, will be begun at Mankato soon: Pres., P. H. Carney, Mankato, Minn.

CHICAGO, GRAND CITY & TERRE HAUTE.—Chartered in Illinois to build a railway from Chicago to Grand City and Terre Haute, Ind. Among the incorporators are: Isaac T. Dyer, W. B. Bass, Chas. J. Strawberg, A. J. McDonald, and others of Chicago.

CHICAGO & HAMMOND.—Chartered in Illinois to build a railway from Chicago to a point on the Indiana line. Among the incorporators are: Frank H. Brown, Albert H. Valentine, Wm. P. Black, and others.

Southwest.—Existing Roads.

TEXAS CENTRAL.—The preliminary survey for the proposed branch from Ross to Waco, Tex., has been begun under the direction of Wm. T. Gould, Res. Engr., Waco, Tex.

GULF, COLORADO & SANTA FE.—A movement is on foot to secure an extension from Colman City to Abilene, Tex. The bonus required by the company has been subscribed, and it is expected that work will begin soon. The line will be about 55 miles long.

MISSOURI PACIFIC.—It is stated that right of way is being secured for the line of the Southwest City & Joplin Ry., which is projected to run from Joplin, Mo., to Southwest City, Mo.

GULF NEWPORT & NORTHERN.—A press dispatch from Waco, Tex., dated Jan. 10, says: "William Davis, Gen. Man. of the Gulf Newport & Northern Ry. and the Pan-American Ry., is in Waco seeking a northern outlet for the first named route, which begins at Alligator Head, on Matagorda Bay, and is being constructed toward Boggy Tank, on the Missouri, Kansas & Texas Ry. Four miles of the Gulf, Newport & Northern have been built and the track-layers are now at work continuing the construction. A movement is on foot here to start a line from Waco to Boggy Tank, and a party to make the survey is being organized. The plan is to build from Waco in the direction of Boggy Tank and to meet the construction forces building from Alligator Head. It is proposed that the new line pass through Moody, giving that town direct communication with Waco, an enterprise which has been agitated frequently by the people of that place and a number of citizens of Waco."

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FT. SMITH, GUTHRIE & WESTERN.—This company has applied for a charter to build a railway from Ft. Smith, Ark., west through Indian Territory to the New Mexico line. G. H. Healy and S. B. Weir, of Beaver, Oklahoma Ter., are interested.

WACO & MOODY.—Preliminary surveys have been completed for a railway from Waco to Moody, Tex., 28 miles. Wm. Davis, F. E. Rogers, and Geo. Parker, Waco, Tex.

PINE BLUFF & SULPHUR SPRINGS.—Chartered in Arkansas to build a railway from Pine Bluff to Sulphur Springs, Ark., seven miles. The officers are: Pres., R. D. Davidson; Vice-Pres., C. E. Philpot; Secy., J. H. Humphrey; Gen. Man., W. A. Leach.

Rocky Mt. and Pacific.—Existing Roads.

GREAT SALT LAKE & HOT SPRINGS.—A coal company is being organized in connection with the railway company to mine coal at Coalville, and the prospects are said to be very favorable for the construction of a branch railway to that place.

ASTORIA & EASTERN.—This company which was recently chartered as a successor to the Astoria & Portland R. R. Co., is reported to have resumed work on the line between Astoria and Portland, Ore. The contractors are: W. H. Remington, of Salt Lake City, Utah, and A. B. & W. W. Corey, of Ogden, Utah.

SPOKANE FALLS & NORTHERN.—Work is making very satisfactory progress on the extension from Northport, Wash., to the International boundary. It is expected that the grading will be completed early in March, and that tracklaying will be finished by April. As soon as this extension is finished it is expected that work will begin on the Nelson & Ft. Sheppard Ry. D. C. Corbin, Spokane, Wash.

Projects and Surveys.

VICTORIA & SIDNEY.—E. G. Tilton, Engr., Victoria, B. C., writes us that the surveys have been completed for this railway from Victoria to Sidney, B. C., 16 miles, and that about three-fourths of the right of way has been secured. Work is now in progress securing the remainder of the right of way and clearing for construction. The contracts for grading will probably be let next month, and it is expected to begin tracklaying in September, and have the road in operation sometime in October. The grading will be nearly all earthwork; the maximum curve 10°, and maximum grade 2%. The principal business will be in agricultural products, lumber and the tourist traffic. The company has been granted the guarantee of the interest on $300,000 of bonds by the provincial government and the city of Victoria, at 2% and 3%, respectively. About $125,000 of the capital stock have been subscribed. Pres., P. C. Dunlevy, and Ch. Engr., J. N. Gray, Victoria, B. C.

MONTEREY & FRESNO.—Chartered in California to build a railway from Fresno to Monterey, Cal., 150 miles.

OURAY & MAYFIELD.—A company has been organized to build a narrow gage railway from Ouray, Colo., to the Mayfield coal beds, a distance of about 16 miles. It is stated that the line will be built within four months.

Foreign.

MEXICO NORTHERN PACIFIC.—All of the interests of this company have been transferred to an English company, which, it is stated, has completed arrangements to put 130 miles of the road, from Deming, N. Mex., to Corallitos, Mex., under construction at once.

MEXICAN INTERNATIONAL.—An official is quoted as saying: "The Monclova & Sierra Mojada Extension will run between the points named. Monclova is situated on the Mexican International in the State of Coahuila. Up to date we have finished grading beyond Cuatro Cienegas, about 45 miles from Monclova. We will begin laying the track the early part of next month, and expect to have trains running early in the summer. The road when completed will be 160 miles long. Between Monclova and Cuatro Cienegas is a fine agricultural valley lying between the mountains. The farmers have had unusually good crops, due to a plentiful supply of water for irrigation purposes. After leaving Cuatro Cienegas, the road strikes into the mountains. This is a splendid mining district and there are good paying mines all along the road. We will count principally upon ore shipments for the profit on the building of the line."

ELECTRIC RAILWAYS.

PEEKSKILL, N. Y.—The Peekskill Surface Ry. Co. has been chartered to build an electric road. Incorporators, Clark D. Rhinehart, Jas. M. Gifford, Wm. R. Thorne and others.

NORRISTOWN, PA.—The Norristown Passenger Ry. Co. will change its motive power to electricity.

PHILADELPHIA, PA.—Chartered, Jenkingtown Electric Ry. Co.; capital stock, $150,000; Pres., Wm. Wharton, Jr.

SAYRE, PA.—Chartered, Waverly, Sayre & Athens Electric Ry. Co., Waverly to Athens; capital stock, $25,000; Pres., A. U. M. Broadhead, Jamestown, N. Y.

WASHINGTON, D. C.—A bill has been introduced in the Senate to incorporate the Chesapeake & Washington Underground Electric Ry. Co. The following are the incorporators: Henry Carey, of New York; Luttrell Murphy, of California; Jno. D. Parsons, of Virginia; Geo. W. Tibbetts, of Washington State, and W. K. Mendenhall, Jno. W. Parsons and Woodbury Wheeler, of Washington, D. C. Capital stock is to be $25,000 per mile, and the motive power of road is to be electricity.

CUYAHOGA FALLS, O.—The project for building an electric railway south to Akron, and north to Silver Lake, in all seven miles, has been received. No less than three companies are engaged in a lively competition for the franchise, one being represented by T. J. Walsh, and claimed to be backed by the Thomson-Houston Co., the second by Mr. Beatty, claiming to represent Brico & Thomas and Hon. Charles Foster, the third, the Akron St. Ry. Co. (Selberling), whose tracks are already within about two miles of Cuyagoha Falls.

DURHAM, N. C.—It is reported that an electric railway will be built from East Durham to West Durham.

ALTON, ILL.—The Alton Electric St. Ry. Co., has been chartered with a capital stock of $250,000. Incorporators: H. G. McPike, J. F. McGinnis, Manning Mayfield.

CHICAGO, ILL.—Chartered, Englewood & Chicago Electric St. Ry. Co.; capital stock, $1,000,000; incorporators: Jas. P. Wallette, Wm. H. Comstock, F. W. Pringle, and others.

SUPERIOR, WIS.—Chartered, Belt Line Electric Co., capital stock, $600,000; incorporators: R. C. Pope, G. R. Smith, and W. B. Petry.

HORSE AND MOTOR RAILWAYS.

BROOKLYN, N. Y.—Chartered, Twenty-third St. Ferry & Newtown R. R. Co.; capital stock, $75,000; incorporators: Peter Wyckoff, John J. Cooney, Theo. F. Jackson, and others.

LANCASTER, PA.—Chartered, Lancaster & Terre Hill Ry. Co.; capital stock, $200,000; Pres., John D. Skiles, Lancaster, Pa.

LANCASTER, PA.—Chartered, Conestoga Valley Ry. Co.; capital stock, $600,000; Pres., John A. Coyle.

STEELTON, PA.—Chartered, Lancaster & Middleton Ry. Co.; capital stock, $500,000; Pres., Luther S. Bent.

TAYLOR, PA.—Chartered, Lackawanna St. Ry. Co.; capital stock, $60,000; Pres., J. W. Houser.

KIRKWOOD, MO.—Chartered, St. Louis & Kirkwood Rapid Transit Co.; capital stock, $10,000.

HIGHWAYS.

PENNSYLVANIA.—It is proposed to extend the Squirrel Hill road from Uniontown to McKeesport. Capt. Sam Brown has a charter for a bridge across the river at Nine-Mile Run, and the right of way has been secured from the authorities of Mifflin township, in connection with a franchise from the borough of Homestead.

BRIDGES, TUNNELS AND CANALS.

TROY, N. Y.—The Troy & Green Island Bridge Co. has been organized to build a bridge across the Hudson River at Dauw St.

AURORA, ILL.—An agreement has been made between the city and the Chicago, Burlington & Quincy R. R. Co. by which the company will construct a viaduct over Spring St. before July 1, 1893.

KANSAS CITY, MO.—The Missouri Pacific Ry. Co. will build a bridge to cost about $100,000 over the Kaw River.

WATER-WORKS.

New England.

LEWISTON, ME.—A new supply from Lake Auburn is talked of.

MANCHESTER, N. H.—Authority to issue $200,000 of bonds for a high service system is being sought.

NORTH ANDOVER, MASS.—The State Board of Health has approved Great Pond as a source of supply for the proposed new works.

ENFIELD, CONN.—The Hazardville Water Co. has been incorporated; $10,000; A. D., A. G. and H. E. Bridge.

Middle.

JEFFERSON, N. Y.—Subscriptions for stock of a proposed water company are being secured. Isaac Peaslee and Dr. R. Hubbell are looking up prices of pipe.

NEW HARTFORD, N. Y.—I. N. Terry, R. V. Sherman and three others have been appointed water commissioners. An election may be held to decide whether works will be built.

NEW YORK, N. Y.—Bids are wanted until Jan. 31 for furnishing stop cocks, hydrants, wooden hydrant boxes and cast iron stop cock boxes; also for laying water mains in about 20 streets. M. T. Daly, Comr. Pub. Wks.

WINDHAM, N. Y.—A franchise may be granted to John A. Longyear, with a provision for ten hydrants at a rental of $20 each per year.

MALVERN, PA.—The Malvern Water Co. may improve its plant so as to furnish fire protection; Secy., Geo. B. Johnson.

NESCOPECK, PA.—The Silver Brook Water Co. has been incorporated; $10,000; Treas., Henry S. Schobert, Wapwallopen, Pa.

PHILADELPHIA, PA.—Councils has authorized a loan of $405,000 for extensions at the Spring Garden pumping station, $370,000 for improvements at the Lardner's Point station and $225,000 for a new pumping station for Queen Lane reservoir.

PINE GROVE, PA.—Estimates for works place the cost at about $20,000. Feb. 21 the people will vote for or against the project.

PLAINS, PA.—The recently charted Susquehanna Water Co. proposes to build works to supply this place and Mill Creek. Pres., Maxwell Chapman; Secy., John S. Macknight; Treas., O. B. Macknight.

UNIONDALE, PA.—The Uniondale Water Co. has been incorporated; $10,000; Treas., Levi A. Patterson.

BROOKLYN, MD.—Brooklyn & Curtis Bay Light & Water Co. wishes bids for extending its mains from Curtis Bay to Brooklyn. An 80-ft. stand-pipe has been built at Curtis Bay. Pres. and Treas., Dr. S. L. Frank; Secy., N. C. Pennington.

LAUREL, MD.—The establishing of works is under consideration.

Southern.

ASHEVILLE, N. C.—The 750,000-gallon stand-pipe connected with the works burst Jan. 22.

NEW BERNE, N. C.—Address Cy. Clk W. D. Wallace regarding proposed works.

ATLANTA, GA.—It is reported that an additional pumping engine and boilers at the new works are proposed, and also a duplicate force main.

CRESCENT CITY, FLA.—Miller & Cash have been granted a franchise.

TULLAHOMA, TENN.—Dr. J. E. Thompson has made a proposition to build works here.

LEXINGTON, KY.—Attention is called to a typographical error in the advertisement in recent issues of this journal asking for proposals for a dam for the water company, by which error it was made to appear that the dam will be of masonry. The structure will be of earth, with but a small amount of masonry.

North Central.

GENEVA, O.—Engr. J. B. Strawn, Salem, has made an estimate for works here.

SOUTH CHARLESTON, O.—Plans for works have been submitted to the council by Engrs. Smith & Prettyman.

GREENFIELD, IND.—O. C. Irwin & Co. have made an offer to put in a pumping plant and operate the same, and to pay one-half the cost of sinking wells provided the city will put in a distributing system. The firm would furnish water for public purposes free on condition that it receive the rental from private consumers. The same firm built the electric light plant.

JACKSON, MICH.—It is stated that Drs. C. J. R. Hanna and Z. W. Waldron, members of the State Board of Health have reported to Mayor Brooks that the water from the river being used for domestic purposes is "impure, offensive and unwholesome, and unfit for use." Last spring the city voted to issue $70,000 of bonds for improvements, but nothing has yet been done.

WINNETKA, ILL.—Bids will be received until Feb. 7 for an intake pipe, extending into Lake Michigan and for a pumping plant and stand-pipe. Later, bids for pipe will be received.

Northwestern.

WHEATLAND, IA.—The water tank of the new works burst Jan. 16, upon being filled.

Southwestern.

AUSTIN, TEX.—Bids are wanted until March 1 by John MacDonald, Mayor, for 8,676 tons of cast iron pipe and 173 tons of specials. W. J. Ollphant, Secy. Bd. Pub. Wks.

GLOBEVILLE, COLO.—The people, by a vote of 38 to 7, have approved the granting of a franchise to the Globe Water Co.

LEADVILLE, COLO.—The Leadville Water Co. has increased its capital stock to $400,000.

LINKVILLE, ORE.—An effort will be made to secure authority to issue $10,000 of water and light bonds and to change the name of the town to Klamath Falls.

Pacific.

PALOUSE, WASH.—The Council is considering the erection of a stand-pipe.

ARTESIAN WELLS.

AURORA, ILL.—It is reported that the City Clerk has been instructed to request bids for a third well.

IRRIGATION.

ROCKY FORD, COLO.—G. M. Hall, Secy. Rocky Ford High Line Canal Co., informs us that a contract for a pile dam across the Arkansas River at the head of the company's canal has been awarded to F. F. Knowles, Las Animas, for $4,392. The dam will be 400 ft. long, 16 ft. wide at the base and 4 ft. above the grade of the canal. It will be formed by three rows of oak piles, a double row of 14-ft. sheet piling on the upper side and a double floor of 2-in. plank on and at the foot of the inner side of the dam. There will be required 153 piles and 75,000 ft. of lumber. W. C. Burke, Engr.

SELMA, CAL.—It is stated that J. S. Eastwood, Engineer of the Sunset Irrigation District, Fresno Co., has prepared a report and new plans for the work, including 285 miles of distributing canals, a large storage reservoir, pumping plant, and supply canals to irrigate 300,000 acres of land. Secy., M. McWhorter.

NEW COMPANIES.—Nebraska & Northwestern Irrigation Co., Lincoln, Neb.; $1,500,000; W. L. Watson, C. H. Peck, and others. Lethent Water & Land Co., San Francisco, Cal.; $5,000,000.

SEWERS.

BOSTON, MASS.—The Metropolitan Sewerage Commissioners will receive bids until Feb. 11 for section 37 of the main sewer, in East Boston; length 4,860 ft., average cut 28.6 ft., maximum external diameter 68 ins.; estimated masonry 1,550 cu. yds.

EASTHAMPTON, MASS.—J. H. Sawyer, Chn. Sewer Com., informs us that plans for a separate system have been prepared by McClintock & Woodfall, Boston, approved by the State Board of Health, and adopted by the Commission. The legislature has been petitioned for authority to issue bonds for construction, and it is hoped that at least a part of the system may be put in this year. For the present the discharge will be into the Manhan River, below the village, and an iron main will carry the sewage through the mill pond to a place below the dam. If the town shall be required to filter the sewage, it is thought that suitable material for filter beds is at hand.

HOLYOKE, MASS.—The legislature has been petitioned for authority to issue bonds for $250,000 for a sewerage system for Elmwood and Oakdale.

LENOX, MASS.—Several plans have been presented for sewage disposal, and Thos. Post, H. Kuhn and T. F. Mackay have been appointed to act with the selectmen in investigating the subject. The committee will report on Feb. 13.

MERIDEN, CONN.—About $30,000 will be spent for lateral sewers this season. The trunk and outlet sewers, costing about $130,000, are nearly completed; A. Brazoz & Son, Middletown, are the contractors. W. S. Clark, Cy. Engr.

MEDINA, N. Y.—Fred. L. Downs, Mayor, informs us that bids will probably be asked within a month for a brick sewer, to cost about $23,000.

NEW YORK, N. Y.—The Commissioner of Public Works will receive bids until Jan. 31 for sewers in 141st, 142d and 143d Sts., between Lenox and Seventh Aves.

ROCHESTER, N. Y.—The following bids were received for section 6 of the East Side trunk sewer: T. F. Moore, Buffalo, $124,885; Bruff, Horn & Co., $137,332; Chambers & Casey, $153,209; Robinson & Pond, $154,790; Whitmore, Rauber & Vicinus, $163,797; Lauer & Hagaman, $163,841; Brayer & Albaugh, $174,046. Mr. Moore, the lowest bidder, also made the lowest time offer, 265 days.

ROME, N. Y.—Plans and specifications for a complete separate system have been prepared by the Stanwix Engineering Co. About 27 miles of pipe will be required at an estimated cost of $225,700.

ATLANTIC HIGHLANDS, N. J.—The Council will receive bids until Feb. 8 for a sewerage system. See advertisement.

PHILADELPHIA, PA.—The new loan authorized includes $1,250,600 for main sewers, $250,000 being for the Aramingo Canal.

READING, PA.—The Committee on Sewers has asked for $156,000 for sewers for this season.

MACON, GA.—C. W. Hendrick, Cy. Engr., writes us that a committee has been named to secure the issue of bonds for a complete system of sewerage. S. B.

Price, T. C. Burke and Henry Horne are members of the committee. It is claimed that the desired system will cost about $200,000. The City Engineer has completed plans for the system of sewers for Vineville.

IRONTON, O.—We are informed by J. R. C. Brown, Cy. Engr., that bids will be received until Feb. 17 for the following sewer work: 42-in. double-ring brick, cut from 13 to 26 ft., 800 ft., with 200 ft. of 24-in. iron pipe outlet; 36-in. double ring brick, laid in creek bottom, cut from 1 to 10 ft., 3,000 ft.; 30 to 34-in. single ring brick, cut from 10 to 18 ft., 4,500 ft.; estimated cost, $20,000.

LONDON, O.—Plans for a sewerage system have been prepared by Frank Snyder, Columbus; estimated cost, $73,000.

INDIANAPOLIS, IND.—The Board of Public Works will receive bids until Jan. 30 for three main sewers and one local sewer.

GRAND RAPIDS, MICH.—The City Engineer has prepared plans for a trunk sewer to drain the district on the west side of the river; estimated cost, $33,017.

RED JACKET, MICH.—Bids are asked until March 1 for about 26,216 ft. of 8 to 42-in. pipe and brick sewers. See advertisement. C. F. Loweth, Consult. Engr., St. Paul, Minn.

AURORA, ILL.—Sewer district No. 2 will have a frontage of about 7.5 miles, and the estimated cost of sewers is $70,000.

MONMOUTH, ILL.—We are informed by Thos. S. McClanahan, Cy. Engr., that contracts will soon be awarded for about 30,000 ft. of 9 to 24-in. pipe and 1,040 ft. of 30-in. brick sewers, 45 manholes and 38 catch basins. About 9,354 ft. of 12 to 18-in. sewers have been constructed this season.

OSHKOSH, WIS.—We are informed by H. G. Finch, Cy. Engr., that plans are being prepared for 1½ or 2 miles of sewers.

HASTINGS, MINN.—The City Auditor will receive bids until March 14 for a sewer from the jail to the Mississippi River.

SIOUX FALLS, S. DAK.—D. C. Rice, Cy. Engr., informs us that the contracts for the sewerage system, advertised to be awarded Jan. 16, were not awarded because the bill regulating the assessments and payment of sewerage systems in cities has not yet been passed by the legislature. The work to be done this year is estimated to cost over $150,000, and will probably be readvertised next month. The cost of construction will be increased because of a large amount of rock to be excavated.

BOULDER, COLO.—A special committee, including the Mayor, has been to Colorado Springs and Greeley to investigate the sewer question. It is thought that the question of issuing bonds for a system will come up at the election in April.

DENVER, COLO.—The City Engineer has been directed to prepare plans for sewers estimated to cost $125,000. We are informed that over 20 miles of sewers are planned to be constructed next season.

OAKLAND, CAL.—The City Engineer is preparing plans for an intercepting sewer to drain 1,300 acres on the east side of Lake Merritt.

REDLANDS, CAL.—The City Trustees have leased six acres of land for a sewer farm, and the sewerage system is to be extended to it.

SALINAS, CAL.—A committee has been appointed to investigate the cost of a sewer system. Bonds will probably be issued. D. F. Davis, Cy. Engr.

STREETS.

WALTHAM, MASS.—The Board of Commissioners of Sewers will receive bids until Feb. 1 for 125,000 granite paving blocks.

BUFFALO, N. Y.—The Department of Public Works will receive bids until Feb. 7 for 10 contracts for paving with asphalt, brick, etc.

NEW YORK, N. Y.—The Commissioner of Street Improvements of Wards 23 and 24 will receive bids until Feb. 7 for grading, curbing, flagging, etc., in there streets.

CUMBERLAND, MD.—The city will pave several streets with fire brick.

ROANOKE, VA.—We are informed by W. E. Thomas, Cy. Clk., that the city is now doing about $200,000 worth of work, and that additional street paving and sewer construction is proposed.

COVINGTON, KY.—The City Engineer estimates that the proposed paving of Greenup St. with brick upon concrete will cost $104,734, and Scott St. with brick upon a macadamized foundation $81,570.

CINCINNATI, O.—The Board of Administration will receive bids until Feb. 16 for paving one street each with brick and cobblestone, and until Feb. 17 for paving two with brick.

CLEVELAND, O.—The City Engineer is planning work for next season. About $1,200,000 worth of grading and paving will be done.

DAYTON, O.—We are informed by J. A. Hahne, Cy. Clk., that the city proposes to pave 10 or 12 miles of streets.

FINDLAY, O.—The City Engineer estimates the cost of paving South Main St. at $40,556.

TOLEDO, O.—The City Clerk will receive bids until Feb. 13 for paving Fulton St. with Trinidad Lake asphalt.

ELKHART, IND.—Bids are asked until Feb. 8 for paving two streets with brick. Chas. L. Kinney, Cy. Engr.

EVANSVILLE, IND.—We are informed by Aug. Pfaffiin, Cy. Engr., that the city proposes to pave about 4½ miles of streets, 96,000 sq. yds., during the coming season with brick. The contracts will be awarded in March.

GOSHEN, IND.—We are informed by Chas. L. Kinney, Cy. Engr., that the city will use about 1,500,000 brick for paving during 1893.

ALTON, ILL.—We are informed by Geo. Dickson, Cy. Engr., that about a mile of brick paving is proposed, and that the work will be advertised in the spring.

STREATOR, ILL.—The City Council will award contracts April 3 and July 3 for the six miles of brick paving noted last week.

ASHLAND, WIS.—We are informed by D. G. Sampson, Cy. Engr., that arrangements will be made in the early spring for paving 1½ miles more of Second St. Cedar blocks will probably be used.

OSHKOSH, WIS.—We are informed by H. G. Finch, Cy. Engr., that the Board of Public Works will award contracts Feb. 10 for cedar block paving and stone curbing on six streets; total length 1.6 miles, average width 40 ft. Plans are also being prepared for about a mile of graveling.

DUBUQUE, IA.—The City Engineer has been instructed to prepare plans for paving several streets with brick.

LYONS, IA.—The City Clerk will receive bids until Jan. 31 for grading, curbing, guttering and paving, with a guaranty for nine years. B. B. Hart, Clinton, Cy. Engr.

NORFOLK, NEB.—The City Engineer, Geo. A. Latimer, is establishing a system of grades, but no other public work is proposed at present.

GALVESTON, TEX.—The City Clerk has been instructed to advertise for bids for 35,479 cu. yds. of street filling. Bonds for $20,000 will be issued.

ELECTRICAL.

BATAVIA, N. Y.—At a special election Jan. 16 both propositions of the electric light company were defeated, owing, it is claimed, to the company insisting upon a contract for five years.

FRANKLINVILLE, N. Y.—It is reported that the Village Trustees have found that the cost of electric light will be but $13 per year per light more than for the present oil lamps.

HAMBURG, N. Y.—The offer of the Hamburg Water & Light Co. to furnish 22 or 25 arc lights at $70 each per year has not been accepted, though the efforts of the Village Board to secure better rates from other companies have proved unsuccessful.

PETERSBURG, VA.—The city contemplates the erection of a municipal electric light plant, and desires to secure the services of an electrical engineer to prepare plans, specifications and all details upon which to solicit bids for the erection of the plant. J. M. Quicke, Chn. Gas and Light Com.

GEORGETOWN, S. C.—We are informed by Geo. R. Congdon, Jr., that there is talk of an electric light plant, but as yet nothing definite has been done.

LOGANSPORT, LA.—An electric light plant is to be put in by the Sabine River Lumber Co.

GALENA, ILL.—The Galena Electric Light Co. will double its capacity and replace the incandescent with arc lights.

GLOBEVILLE, COLO.—A franchise for an electric light plant has been granted to Smith Bros. & Keith.

HIGHLANDS, COLO.—The City Council has granted a franchise to the Denver & Highlands Electric Co. to construct and maintain an electric light and power plant and a gas plant in the city. The company agrees to furnish 2,000-c. p. arc lights to the city at $12 each per month, and to furnish lights to private individuals at 7.5 mills per light per hr. If at any time the prices for lights are reduced in Denver, a similar reduction will be made here.

NEW COMPANIES.—Patten Electric Power Co., Jersey City, N. J.; $100,000; F. J. Patten and G. P. Shockley, New York; J. C. McGuire, Brooklyn. Home Electric Co., Coudersport, Pa.; $10,000; Treas., W. K. Jones. Coleman Battery Co., Chicago, Ill.; $75,000; J. Coleman, Chas. Odell, Clarence Coleman. Hammond Light & Power Co., Chicago, Ill.; $50,000; M. Towle, Alonzo Stephens, F. J. Baker. Mount Carmel Light & Water Co., Mount Carmel, Ill.; $50,000; Wm. S. Teed, J. B. Reid, J. H. Reynolds. Automatic Telephone & Electric Co. of Illinois, Chicago, Ill.; $250,000; J. R. Griffiths, V. C. Sanborn, Sidney Coolidge. Cuero Electric Light, Power & Telephone Co., Cuero, Tex.; $50,000; Otto Starkes, Emil Lesnardt, A. F. Palmer.

CONTRACT PRICES.

CEDAR BLOCK PAVING.—Ashland, Wis.—We are informed by D. G. Sampson, Cy. Engr., that contracts for paving 25,000 sq. yds. with cedar blocks have been awarded to P. McDonnell, Duluth, Minn., at $1.34 and $1.42 per sq. yd.; also the contract for storm sewers, at $1 per lin. ft.

BRICK PAVING.—Monmouth, Ill.—Thos. S. McClanahan, Cy. Engr., informs us that the city has awarded contracts for the following work: Brick paving, 82,937 sq. yds., average cost, including sand, $1.43 per sq. yd.; Berea sandstone curbing, 4 x 20 x 60 ins., 40,960 lin. ft., 48¼ cts. per lin. ft.; extra excavation, 17½ cts. per cu. yd. The brick is laid in two courses, the lower one flat and the upper one on edge, upon subgrade covered with 3 ins. of clean, sharp sand. Between the courses is a cushion of .1 in. of this sand, the cracks are filled, and the whole covered to a depth of .5 in.

PILING.—Cleveland, O.—The lowest bid for the construction of heavy timber protections for the upper and central Seneca St. bridges was that of C. H. Strong & Son, 23¾ cts. per lin. ft. for furnishing and driving white oak piles.

MISCELLANEOUS.

DREDGING.—West Superior, Wis.—We are informed by A. Z. Cooper, Cy. Engr., that bids will probably be asked in about a month for dredging 145,000 cu. yds. The city has awarded contracts for dredging to C. S. Barker, at an average price of 22 cts. per cu. yd. Mr. Barker has contracts, including government work, for about 900,000 cu. yds. of work.

DOCK.—Brooklyn, N. Y.—The estimated cost of the proposed public pier and bulkhead between 43d and 44th Sts., is $127,000 for a pier 400 ft. long, or $143,000 for a pier 600 ft. long.

GARBAGE CREMATORY.—Indianapolis, Ind.—The Board of Public Works has received an offer from W. H. Garretson, Dallas, Tex., to build two Brownlee crematories in this city for $20,000; capacity 100 cu. yds. per day, at a cost for fuel and labor of 50 cts. a ton, or 10 cts. a ton for miscellaneous garbage.

JAIL.—Racine, Wis.—The County Board of Supervisors has accepted the plans of J. G. Chandler for a new $25,000 jail, and will advertise for bids for its immediate construction.

GAS PLANT.—Milwaukee, Wis.—The Milwaukee Gas Light Co. will erect a new plant, to cost not less than $500,000.

GAS COMPANY.—The Mattoon Gas Co., Mattoon, Ill.; $50,000; to build and operate gas-works; Henry C. Rew, Alfred H. Gross, and John C. King.

JETTY WORK.—Galveston, Tex.—The City Clerk has been directed to advertise for bids for 700 ft. of jetty construction, estimated cost $9,500, and for 10 rock mounds on brush mattresses, $4,500.

PIER WORK.—New York, N. Y.—The Department of Docks will receive bids until Feb. 2 for a wooden pier, with appurtenances, including two wooden sewers, near the foot of Canal St., North River.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Brooks Locomotive Works, Dunkirk, N. Y., are building 13 consolidation and eight-wheel engines for the Wisconsin Central, and a ten-wheel engine for the Cincinnati, Lebanon & Northern. The Baldwin Locomotive Works, Philadelphia, Pa., have orders for 20 four-cylinder compound tank engines for the Metropolitan & West Side Elevated, of Chicago, and 10 ten-wheel engines for the Monterey & Mexican Gulf. The Pittsburg Locomotive Works, Pittsburg, Pa., are building 7 consolidation engines for the Cincinnati, Hamilton & Dayton. The Schenectady Locomotive Works, Schenectady, N. Y., have delivered 2 ten-wheel passenger engines to the Cleveland, Cincinnati, Chicago & St. Louis. The Grant Locomotive Works, Chicago, Ill., are building a ten-wheel engine for the Elgin, Joliet & Eastern. The Central of New Jersey will add 30 engines to its equipment.

CARS.—The Gilbert Car Mfg. Co., Troy, N. Y., has an order for 100 cars for the Metropolitan & West Side Elevated, of Chicago. The Wells & French Car Co., Chicago, Ill., has an order for 25 Rogers ballast cars for the Minneapolis, St. Paul & Sault Ste. Marie. The Pullman Palace Car Co., Chicago, Ill., has built 500 coal cars of 60,000 lbs. capacity, for the Elgin, Joliet & Eastern, and has an order for 10 sleeping cars for the Chicago, Burlington & Quincy. The Ensign Mfg. Co., Huntington, W. Va., is building 100 cattle cars for the Canada Cattle Car Co. The United States Car Co., Anniston, Ala., is building 50 Thacher pneumatic dump cars. The Caswell Car Co., of Chicago, has been incorporated by Wm. A. Caswell, M. N. Naber and J. M. Cameron, with a capital stock of $500,000. The Piedmont Car Co., of Norfolk, Va., has been incorporated by Chicago capitalists; Pres., Charles A. Arnold; Secy., Chester B. Little.

CAR WORKS.—The Jones Vestibule Sleeping Car Co. has bought five more acres of land adjoining its property, some six miles west of Denver. Work, it is reported, is being pushed on the new building, as follows: Mill, 80 x 250 ft.; erecting shop, 80 x 250 ft.; paint shop, 80 x 250 ft.; blacksmith and machine shop, 60 x 250 ft.; foundry, 60 x 200 ft., and brass foundry, 35 x 40 ft. The Jones Car Co. Works, Schenectady, N. Y., have been sold to E. C. White & Co., of New York, manufacturers of car wheels and trucks, for $65,000. The new proprietors have purchased all claims against the plant, and it is expected that operations will be resumed in the spring. The Wagner Palace Car Co. has purchased ground near the Mill Creek Valley terminal yards in St. Louis, Mo., for the erection of Western car-shops. The works will employ about 300 hands.

GROOVED ROLLERS.—Three grooved Pope reversible rollers have been purchased by A. Van Wagner & Co., of Syracuse, N. Y., for use in constructing the water-works reservoir at that place. This grooved roller is said to have been found to be more effective than the smooth roller in compacting loose earth, especially where the surface is lumpy. It is manufactured by R. C. Pope, Chamber of Commerce Building, Chicago.

STONE CRUSHING.—A crusher, engine and boiler are included in the estimate of the Superintendent of Public Works, New Bedford, Mass., the estimated cost being $6,000.

THE PORT CHESTER WAGON CO., Port Chester, N. Y., is building an addition to its shops to enable it to manufacture a heavy contractor's wakon, having 2-in. solid steel axles, with the front wheels turning under the body.

NEW COMPANIES.—Excelsior Wooden Pipe Co., San Francisco, Cal.; $250,000; Charles A. Hooper, E. F. Burrell and E. C. Flagg. Railway Torpedo Signal Co., Sing Sing, N. Y.; $5,000; John Gibney and Smith Lent. Union Sewer Pipe Co., Akron, O.; $20,000; Wm. McFarlin, F. H. Adams and C. C. Benner. American Automatic Switch Co., Portland, Me.; $200,000; G. W. Anderson, F. A. Fernald and J. N. Dewal, all of Boston, Mass. Morrison Convertible Car Seat Co., Chicago, Ill.; $500,000; J. D. Morrison, George W. Amos and H. Holyhauer. St. Louis Sewer Pipe Co., St. Louis, Mo.; $100,000; J. T. Wallace, J. R. Lewis and J. W. Sharpe. Troy Valve Co., Troy, N. Y.; $30,000; E. Bussey, C. A. McLeod and Wm. Ross.

CURRENT PRICES.

RAILS.—New York: $29 at eastern mills, $30 at tidewater; old rails, $17 for iron, and $14 to $15 for steel. Pittsburg: $29; old rails, $20 for iron and $15.50 to $16 for steel. Chicago: $30 to $32 for standard sections; old rails, $18 to $18.25 for iron and $11.50 to $13.25 for steel.

TRACK MATERIAL.—New York: steel angle bars, 1.6 to 1.65 cts.; spikes, 1.9 to 2 cts.; track bolts, 2.4 to 2.6 cts. with square and 2.7 to 2.8 cts. with hexagon nuts. Pittsburg: splice bars, 1.75 to 1.77 cts. for iron and 1.8 cts. for steel; iron and steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.65 to 1.75 cts. for iron and steel; spikes, 2 to 2.05 cts. at mill; track bolts, 2.6 to 2.7 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows at Pittsburg: 55% and 10%, and 47½% and 10% on black and galvanized butt welded; 65% and 10%, and 55% and 10%, on black and galvanized lap welded. Casing, 57½%.

FOUNDRY PIG IRON.—New York: $13.25 to $15. Pittsburg: $12 to $14. Chicago: $13.25 to $14.25.

LEAD.—New York: 3.85 cts.; Chicago: 3.6 to 3.7 cts.; St. Louis: 3.57 to 3.6 cts.

STRUCTURAL MATERIAL.—New York: beams, 2 to 2.25 cts. for large lots, and 2.25 to 2.75 cts. for small lots; channels, 2.1 to 2.2 cts.; angles, 1.85 to 2 cts.; tees, 2.1 to 2.3 cts.; sheared iron plates, 1.85 to 2.1 cts.; steel plates, 1.85 to 2 cts. for tank, 2.1 to 2.25 cts. for shell, 2.4 to 2.65 cts. for flange, 2.6 to 2.8 cts. for firebox. Pittsburg: beams, 2 to 2.1 cts.; channels, 2 to 2.1 cts.; angles, 1.65 to 1.75 cts.; tees, 2.1 to 2.15 cts.; Z bars, 1.85 to 1.9 cts.; universal mill plates, 1.7 to 1.75 cts.; sheared steel bridge plates, 2.1 to 2.25 cts.; refined bars, 1.7 cts. for iron and steel; steel plates, 1.7 to 1.75 cts. for tank, 1.95 to 2.1 cts. for shell, 2.05 to 2.1 cts. for flange, 3.4 to 3.5 cts. for firebox. 1.9 to 2 cts. for bridge. Chicago: beams, 2.17 to 2.25 cts.; channels, 2.27 to 2.5 cts.; angles, 1.9 to 2 cts.; tees, 2.2 to 2.3 cts.; sheared plates, 1.9 to 1.95 cts; universal plates, 1.9 to 2 cts.; steel plates (at mill), 1.9 to 2 cts. for tank, 2.12 to 2.25 cts. for shell, 2.25 to 2.75 cts. for flange, 2.7 to 2.8 cts. for firebox.

Notice to Sewer Contractors!

OFFICE OF THE COMMON COUNCIL,
RED JACKET, MICH., Jan. 10, 1893.

Sealed proposals for the construction of a system of sewerage and drainage will be received at the office of the Village Recorder of the village of Red Jacket, Mich., until 3 o'clock p. m. of the 1st day of March, 1893, at which hour the bids will be publicly opened and read at a meeting of the Village Council held for that purpose.

Each proposal shall be accompanied by a certified check on some local bank, for the sum of $500, made payable, unconditionally, to the order of the Treasurer of the Village of Red Jacket, Mich.; such check will be considered as a surety of good faith in the party making the bid.

The person or persons to whom the contract may be awarded will be required to attend at the office of the Village Recorder, with the sureties offered by him or them, and execute the contract within seven days, Sunday excepted, from the date of the notification of award, and in case of failure or neglect so to do he or they will be considered as having abandoned it, and as in default to the Village of Red Jacket, Mich., in which event the check accompanying the proposal shall be forfeited to the Village of Red Jacket, or in the event of the rejection of the proposal the check will be returned.

The right is reserved to decline any or all proposals if deemed for the interests of the village.

The following is the Engineer's estimate of quantities by which the bids will be compared, viz.:

475 lineal ft., 42-in., 2-ring brick sewer,
330 " " 38 " 2 " " "
330 " " 32 " 1 " " "
262 " " 26 " 1 " " "
203 " " 24 " 1 " " "
204 " " 22 " 1 " " "
575 " " 18 " vitrified pipe sewer,
170 " " 15 " " " "
1,282 " " 12 " " " "
21,335 " " 8 " " " "
1,050 " " 12 " " " catch-basin connections,
32 catch-basins,
12 manholes in brick storm sewers,
10 " " pipe " "
79 " " " sanitary sewers,
6 8-inch flush tanks,
5 6 " " "
48 lamp holes,
325 cu. yds. of rock excavation,
2,000 lineal ft. of 6-inch vitrified pipe house connections.

These quantities are to be considered as approximate only, and given merely as a basis of comparison. The village expressly reserves the right of increasing or diminishing the same, to the extent of 20% in the aggregate, as may be deemed necessary.

Proposals must be made upon blanks furnished by the Village Recorder or the Engineer; all proposals which are not in all respects in conformity with this notice will be considered as informal and be rejected by the Council.

Plans and specifications of the work are on file, and may be seen at the office of the Village Recorder; also at the office of the Consulting Engineer.

P. RUPPE, JR., President.
H. J. VIVIAN, Village Clerk pro tem.
CHAS. F. LOWETH, Consulting Engineer,
3-4t Drake Block, St. Paul, Minn.

To Sewer Contractors.

Sealed proposals will be received by the Board of Sewer Commissioners of the City of Pawtucket, R. I., until Friday, February 10, 1893, at two o'clock p. m., for constructing a sewer in Central Avenue from the Blackstone River to Mendon Avenue.

Said work is divided into two sections:
Section A.
460 ft. sewer 4 ft. 6 ins. diameter.
2,350 " " 7 ft. 3 ins. " in tunnel.
Section B.
150 ft. sewer 7 ft. 3 ins. diameter open cut.
1,640 " " 5 ft " " "

Each section will be treated as a separate contract in canvassing bids and making awards.

Each proposal must be accompanied by a certified check to the amount of five hundred (500) dollars for each section bid upon.

Proposals must be inclosed in envelopes sealed and marked, "Proposals for Constructing a Sewer in Central Avenue."

The Board of Sewer Commissioners reserve the right to reject any and all bids.

Plans and specifications may be seen at the office of the Board of Sewer Commissioners, Room 8, Music Hall Building, Main Street, Pawtucket, R. I.

2-4t A. R. SWEET, Superintendent.

Notice To Contractors of Street Paving.

Sealed proposals will be received until 5 p. m. Thursday, February 2, 1893, by the undersigned for the City of Easton, Pa., at the office of the City Engineer, Municipal Building, for the paving of Walnut and South Fourth Streets with Vitrified Paving Brick on a six-inch concrete base in accordance with the plans and specifications on file in the office of the City Engineer.

The approximate quantity of paving is 9,800 sq. yds.

Each proposal must be made upon the "form" furnished by the City Engineer.

No bid will be considered unless accompanied by a certified check, drawn to the order of the Treasurer, New York draft, or money, to the amount of $500. All such deposits, except that of the successful bidder, will be returned to the persons making the same, within ten days after the contract is awarded. If the successful bidder shall refuse or neglect, within ten days after notice that the contract has been awarded to him, to execute the same and furnish a bond acceptable to a joint convention of councils in the sum of $10,000, the amount of deposit made by him shall be forfeited to and retained by the City of Easton as liquidated damages for such neglect or refusal; but if he shall execute the contract within the time aforesaid, the amount of such deposit will be returned to him.

Samples of brick, sand and gravel, properly labeled, must be submitted on or before February 1, 1893.

The city reserves the right to reject any or all bids.

Specifications, blank forms and all available information will be furnished on application to this office.

H. R. FEHR,
2-3t City Engineer.

TO SEWER CONTRACTORS.

Sealed proposals will be received by the Board of Sewer Commissioners of the Village of Stamford, N. Y., at the office of the President until Wednesday, Feb. 1, 1893, for furnishing all labor and material for the construction of disposal works and sewers, with the necessary manholes, lampholes, etc., according to the plans and specifications now on file in the office of the President. Each proposal shall be signed by the bidder and accompanied by a certified check or cash to the amount of ($500.00) five hundred dollars, made payable to the Board of Sewer Commissioners, conditioned upon the execution of the required contract, and the required bond for the faithful performance of the terms of the contract in case of award.

The Board reserve the right to reject any and all proposals.

By order of the Board of Sewer Commissioners. C. L. ANDRUS, Pres.
1-4t

Edinburgh, Ind., Water-Works.

Sealed proposals will be received until noon, Monday, January 30, 1893, by the President and Board of Trustees of the town of Edinburgh, Indiana, for the material and labor, together and separately, required to construct a system of water-works. Each bid must be accompanied by a certified check to the amount of $100, as a guarantee of good faith. The right to reject any or all bids reserved. Plans and specifications can be seen at the office of Town of Edinburgh, Indiana; also at office of Consulting Engineer, John J. Hainsworth, Franklin, Indiana. M. DUCKWORTH, Pres. Board of Trustees. 53-5t

World's Fair Route.

The Cincinnati, Hamilton & Dayton R. R. is the only line running Pullman's Perfected Safety Vestibuled Trains, with Chair, Parlor, Sleeping and Dining Car Service, between Cincinnati, Indianapolis and Chicago, and is the Only Line running Through Reclining Chair Cars between Cincinnati, Keokuk and Springfield, Ill. It is the popular line between Cincinnati and St. Louis with Through Sleeping Cars on Night Trains and Chair Cars on Day Trains, and the Only Direct Line between Cincinnati, Dayton, Lima, Toledo, Detroit, the Lake Regions and Canada.

Tickets on sale everywhere, and see that they read C., H. & D., either in or out of Cincinnati, Indianapolis, or Toledo. E. O. McCORMICK, General Passenger and Ticket Agent, Cincinnati, O. 51-20t-eow

Have you ever tried the "Extensible Sewer Brace"? See advertisement of the Dunn Mfg. Co. on Page ix.

IMPROVEMENT OF PHILADELPHIA HARBOR.—U. S. Engineer Office, 1428 Arch St., Philadelphia, Pa., December 30, 1892.—Sealed proposals, in triplicate, will be received at this office until 11 a. m., Tuesday, January 31, 1893, and then publicly opened, for dredging and removal of wharding in Philadelphia Harbor, and the depositing and spreading of material on League Island. Specifications, blank forms and all available information will be furnished on application to this office. C. W. Raymond, Major Corps of Engineers, U. S. Army. 1-4t

TREASURY DEPARTMENT, OFFICE Supervising Architect, Washington, D. C., January 13, 1893.—Sealed proposals will be received at this office until 2 o'clock p. m. on the 9th day of February, 1893, and opened immediately thereafter, for all the labor and materials required for the interior finish and plumbing of the U. S. Post Office, etc., building at Scranton, Pennsylvania, in accordance with the drawings and specification, copies of which may be had at this office, or the office of the Superintendent at Scranton, Pa. Each bid must be accompanied by a certified check for a sum not less than 2% of the amount of the proposal. The right is reserved to reject any or all bids, and to waive any defect or informality in any bid, should it be deemed in the interest of the Government to do so. All bids received after the time stated will be returned to the bidders. Proposals must be inclosed in envelopes, sealed and marked "Proposal for the Interior Finish and Plumbing of the U. S. Post Office, Etc., Building at Scranton, Pa.," and addressed to W. J. Edbrooke, Supervising Architect. 3-2t

CITY OF DEERING.

NOTICE TO SEWER CONTRACTORS.

Sealed proposals for the construction of sewer extensions in the City of Deering will be received at the office of City Clerk, Deering, Me., until noon, February 15, 1893.

The work in general will comprise the following lengths:

24-inch pipe sewer, about 2,152 feet.
20 " " " " 1,342 "
12 " " " " 3,285 "
10 " " " " 731 "
8 " " " " 7,706 "

Every proposal shall be signed by the bidder and marked, "Bids for Sewer Extension," and addressed to City Clerk, P. O., Woodfords, Me.

Specifications may be obtained and plans seen at the office of Haley & Cummings, Engineers, Portland, Me. The Committee on Sewers, City of Deering, reserve the right to reject any or all bids. (Signature.)

J. H. HUTCHINS,
WM. W. MITCHELL,
GEO. W. LEIGHTON,
Committee on Drains and Sewers.
WALTER FICKETT, Street Commissioner.
Deering, Me., January, 1893. 4-3t

TO CAST IRON PIPE MANUFACTURERS.

Sealed proposals will be received until 12 o'clock m. on March 1, 1893, for furnishing the City of Austin, Texas, with 8,676 tons of cast iron water pipe and 173 tons of special castings, f. o. b. cars at Austin. Bids must be addressed to John McDonald, Mayor, Austin, Texas, and indorsed "Proposals for Pipe and Special Castings." The right to reject any or all bids is reserved. Full information can be obtained from the undersigned.

W. J. OLIPHANT,
Secretary Board of Public Works, Austin, Texas. 4-5t

PROPOSALS FOR SEWER CONSTRUCTION WANTED.

Ironton, Ohio, wants proposals to construct main sewers 8,300 feet long, and 42.36, 34.32 and 30 inches diameter in one (4½-in.) and two (9-in.) ring brickwork in cuts from 1 to 26 feet deep; together with 200 feet of 24-inch iron pipe outlet. Bids to be sealed and received by the undersigned up to 12 o'clock noon, sun time, Saturday, February 18, 1893.

For further information, blank proposals, etc., address,

J. R. C. BROWN, City Engineer,
HALSEY C. BURR, City Clerk, Ironton, Ohio. 4-2t

COMMONWEALTH OF MASSACHUSETTS.

METROPOLITAN SEWERAGE COMMISSIONERS—NOTICE TO CONTRACTORS.

Sealed bids for building Section 37 of the Metropolitan Sewerage System in East Boston, in accordance with the form of contract and specifications to be furnished by the Board of Metropolitan Sewerage Commissioners, will be received by said Board at its office, 93 Lincoln Street, Boston, Mass., until 12 o'clock m. of Saturday, February 11, 1893.

No bid will be received unless accompanied by a certified check for the sum of $1,000.

All bids must be made upon the blank forms furnished by the Board.

Some other particulars are estimated to be as follows: Length of section, 4,860 feet; average depth, about 28.6 feet; maximum external diameter, 68 inches; estimated cubic yards, brick and other masonry, 1,550.

Plans can be seen and specifications and forms of contract can be obtained at the above office.

Each bidder is required to make a statement indicating what sewer and similar work he has done, and to give references that will enable the Board to judge of his business standing.

The Board reserves the right to reject any and all bids.

HOSEA KINGMAN,
TILLY HAYNES,
HARVEY N. COLLISON,
Board of Metropolitan Sewerage Commissioners of Massachusetts.
HOWARD A. CARSON, Chief Engineer. 4-2t

U. S. ENGINEER OFFICE, NEWPORT, R. I., January 16, 1893.—Sealed proposals, in triplicate, for stone work at Point Judith, R. I., will be received at this office until 12 m., noon, on the 24th day of February, 1893, and then opened. The attention of bidders is invited to the Act of Congress approved August 1, 1892, Sections 1 and 2 (Public No. 193). Full information furnished on application. W. H. BIXBY, Captain Corps of Engineers, U. S. Army. 4-3t

U. S. ENGINEER OFFICE, Room 46, Appeal Building, Memphis, Tenn., January 18, 1893. Sealed proposals, in triplicate, for the construction of thirty (30) decked barges will be received at this office until 12 o'clock noon of February 1, 1893, and then publicly opened. Specifications, blank forms and all available information will be furnished on application to this office. S. W. ROESSLER, Captain of Engineers. 4-1t

TO SEWER CONTRACTORS.

Sealed proposals will be received at the office of the City Clerk of the City of Monmouth, Illinois, until 12 o'clock noon of Monday, Feb. 6th, 1893, for furnishing labor and material necessary for the construction of the following approximate amount of sewers: 1,133 feet of 30-inch brick; 39,0[illegible] feet of vitrified pipe sewer, from 6 to 24 inches in diameter. Work to be commenced as soon as the frost is out of the ground. Bids to be made upon blanks furnished by the City Clerk. Each bid to be accompanied by a certified check for $500, payable to the City of Monmouth. Plans, profiles, specifications, etc., can be seen at the office of the City Engineer. The right is reserved to reject any or all bids.

J. ARTHUR STEVENSON, City Clerk.
Office of the City Clerk, Monmouth, Ill.
Jan. 21, 1893. 4-2t

Halifax, N. S., Water-works.

Sealed proposals will be received by the Board of Commissioners of City Works of the City of Halifax, Nova Scotia, until 12 o'clock noon on Monday, February 20th, 1893, for the manufacture and delivery of about 2,400 tons of cast iron pipe and necessary specials and valves.

Plans, quantities, specifications and other information can be obtained from the City Engineer.

The Board of Commissioners of City Works hereby reserve the right to reject any or all bids, or accept separate tenders for pipe and specials, and for valves, or any that, in their judgment, will be for the best interest of the City.

No tender will be considered unless accompanied by cash draft or a certified check for five hundred dollars ($500.00) for pipe, and one hundred dollars ($100.00) for valves, payable to the City Treasurer of the City of Halifax as a guaranty that in case the contract is awarded the successful bidder will execute said contract with satisfactory security within ten days after notification of award.

Each bidder will be required to state in his proposal the name and address of his two sureties.

Each proposal must be made on the form furnished by the City Engineer, and must be marked "Tender for Water Pipe" (or valves), and addressed to the Chairman of the Board of Works, City Hall, Halifax, N. S.

By order of the Board:
W. B. McNUTT, Clerk of Works.
F. W. W. DOANE, City Engineer.
City Hall, Halifax, N. S. 2-4t

NOTICE TO CONTRACTORS.

ATLANTIC HIGHLANDS, N. J., WATER SUPPLY AND SEWERAGE SYSTEMS.

Sealed proposals for the construction of systems of water supply and sewerage will be received by the Mayor and Council of the Borough of Atlantic Highlands, New Jersey, until 3 p. m., Wednesday, February 8, 1893. The work contemplates approximately seven miles of pipe sewers, from 8 ins. to 18 ins. in diameter; manholes, flush tanks, and iron outfall sewer into Sandy Hook Bay, and approximately eight miles of water-mains, 4 ins. to 10 ins. in diameter, valves, hydrants, pumping station, stand-pipe, etc. Bids will be received separately for the water and sewerage systems. Work is to be completed June 1, 1893. Certified check for $1,000, drawn to the order of the Borough Treasurer, must accompany each bid. Plans and specifications will be on file in the office of the Mayor at Atlantic Highlands, New Jersey, and at the office of the Engineer in Charge, National Bank Building, Orange, New Jersey, after January 20, 1893. Any or all proposals may be rejected. SOMERS T. CHAMPION, Clerk.
CARROL PH. BASSETT,
Engineer in Charge. 3-3t